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ABSTRACT

This packet contains 13 teacher lesson plans with related student information, job sheets, and task sheets for a block of instruction on motor vehicle refrigeration (air conditioning) systems in a course on auto mechanics. Lesson plans, which are either informational or manipulative in format, take the teacher step-by-step through each lesson. Information provided includes the subject of the lesson, aim, teaching aids, materials needed, references, prerequisite experience of the learner, motivation, presentation of the information (with instructional points in the left column of the plan and related student and teacher materials in the right column), summary, evaluation, and suggested readings for the students. Student job and task sheets break down the students' duties into steps and note the types of equipment and other materials needed. Procedures are illustrated with line drawings. Information sheets are provided for information lessons. (KC)

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MOTOR TRANSPORTATION TECHNOLOGY

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AUTOMECHANICS

BLOCK IX

A-IX

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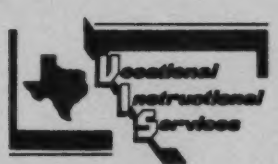

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INFORMATION SHEET
ON
AIR CONDITIONING

IX-A-1(IS)

SUBJECT: Principles of Refrigeration

INTRODUCTORY
INFORMATION:

When you hear the term "Air Conditioning", you usually think of cool, fresh air; actually, an air conditioning system does four things: dehumidifies, purifies, circulates and cools the air. In the automotive field, these are the things we want to happen inside the passenger compartment.

GENERAL INFORMATION:

In the modern automobile, the refrigeration system uses a special compound called refrigerant 12 to provide us with this luxury. Refrigerant 12 which absorbs heat is used over and over again inside a closed system. To show how this cooling process takes place we first need to examine the three laws of refrigeration. Law 1 says that to refrigerate is to remove heat. The absence of heat is cold. So actually when we use the air conditioner in our car we are removing the heat from the passenger compartment and lowering the temperature of the air. Law 2 states that heat will flow to anything that has less heat. Nothing can stop the flow of heat, only slow it down. This law will come into use in the evaporator of the air conditioning system. Law 3 states that for a liquid to change to a gas, it must take on heat, like boiling water. The cooling process takes place inside the evaporator. The refrigerant 12 will absorb heat; when it does this it boils. To reuse the refrigerant 12 requires the incorporation of several other components. The air conditioning compressor pressurizes the heat laden vapor and sends it to the condenser. In the condenser the refrigerant 12 gives up its heat and once again returns to a liquid. Now the refrigerant 12 is sent to the receiver/dehydrator and stored until it is needed again by the evaporator. When it is passed to the evaporator, pressure is greatly reduced and the refrigerant will pick up heat and turn to a vapor, where the cycle starts all over again. Actually this cycle is repeating itself over and over all the time that the air conditioning system is being used.

The refrigerant which is used in automotive air conditioning systems is usually referred to as R-12. R-12 is ideal because of its stability at high and low temperatures. R-12 does not react to most metal such as iron, aluminum, copper or steel and is soluble in oil. It is nonflammable and nonexplosive in a gas or liquid form. R-12 is colorless and odorless in concentrates of less than 20%. It is nonpoisonous except when in direct contact with an open flame. Refrigerant 12 will boil (vaporize) at minus 21.7 degrees F. at sea level. In addition to all of the good characteristics, R-12 can be quite hazardous if safety precautions are not followed.

The following precautions should be followed to prevent personal injury.

1. Wear suitable eye protection; if R-12 is contacted in eyes, wash with cool water and see physician immediately.
2. Do not overheat refrigerant container.
3. Keep R-12 away from open flame; the poisonous gas phosgene is produced.
4. Keep R-12 away from skin.
5. Discharge R-12 in a well ventilated area.
6. Treat R-12 containers with care to avoid rupturing containers.
7. Place a clean cloth over any valve or connection when it is open.
8. Close the shutoff valves provided before disconnecting the lines or fittings.
9. When heat is required to prepare refrigerant for charging a system, never use water above 125°, and never use a torch, stove or radiator as a source of heat.
10. Do not leave refrigerant containers exposed to direct sunlight or carry them in the passenger compartment of a car.
11. Keep all connecting pipes free of dents and kinks.
12. Maintain smooth and unmarked flares on tubing ends and on fittings.
13. When a joint is disconnected, cap the pipe and fitting immediately to prevent the entry of air and moisture.
14. To avoid an explosion, never weld, solder, use a blow torch or steam-clean around or near any part of the air conditioning system.

INSTRUCTOR'S PLAN IX-A-1(I)
INFORMATIONAL LESSON

SUBJECT:	BASIC PRINCIPLES OF REFRIGERATION
AIM:	THE STUDENT WILL BE ABLE TO EXPLAIN THE BASIC PRINCIPLES OF REFRIGERATION THROUGH THE UNDERSTANDING OF HEAT BEHAVIOR AND THE REMOVAL OF HEAT AS A MEANS OF PROVIDING COOL AIR.
MATERIALS:	CHALKBOARD, OVERHEAD PROJECTOR
TEACHING AIDS:	TRANSPARENCIES: I. ED. IX T, FIGURES 1-14 INFORMATION SHEET IX-A-1(IS), "BASIC PRINCIPLES OF REFRIGERATION"
REFERENCES:	AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646 AUTOMOTIVE MECHANICS, CH. 43 AUTO SERVICE AND REPAIR, CH. 32 AUTOMOTIVE SERVICE MANUALS
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST HAVE READ THE RELATED INFORMATION SHEET FOR THIS LESSON AND THOSE ASSIGNED READING LESSONS.

I. PREPARATION (OF THE LEARNER - MOTIVATION)

TODAY AUTOMOBILE AIR CONDITIONING IS NO LONGER A LUXURY, BUT A NECESSITY. BUSINESSMEN AND WOMEN ARE ABLE TO DRIVE TO WORK OR TO APPOINTMENTS IN COMFORT AND ARRIVE FRESH AND ALERT. PEOPLE SUFFERING FROM ALLERGIES ARE ABLE TO TRAVEL WITHOUT THE FEAR OF COMING IN CONTACT WITH DUST OR AIRBORNE POLLENS. THIS IS ACCOMPLISHED BY THE USE OF THE AIR CONDITIONING SYSTEM.

TO UNDERSTAND HOW THE AIR CONDITIONING SYSTEM WORKS, FIRST, REQUIRES AN UNDERSTANDING OF HOW THE HEAT IS REMOVED, BECAUSE ONLY THROUGH THE REMOVAL OF HEAT CAN WE PRODUCE COLD.

TO UNDERSTAND THE REMOVAL OF HEAT WE MUST UNDERSTAND WHAT HEAT IS AND HOW IT AFFECTS US.

WHAT ARE WAYS THAT HEAT CAN BE REMOVED? WHAT EFFECT DOES HEAT HAVE ON MATTER? HOW DOES PRESSURE AFFECT HEAT? TO UNDERSTAND THE BASIC PRINCIPLES OF REFRIGERATION REQUIRES THE UNDERSTANDING OF THESE QUESTIONS.

II. PRESENTATION (OF THE INFORMATION)

A. PRINCIPLES OF BODY COMFORT

1. BODY PRODUCES HEAT

1. FOOD TAKEN IN CONTAINS HEAT IN THE FORM OF CALORIES
2. CALORIES ARE CONVERTED INTO ENERGY AND STORED
3. HEAT IS GENERATED BY CONVERSION PROCESS AND BODY MOVEMENT
4. BODY PROVIDES MORE HEAT THAN IT REQUIRES
5. HEAT MUST CONSTANTLY BE GIVEN OFF OR REMOVED

2. BODY REJECTS HEAT

BODY REJECTS HEAT THROUGH THREE NATURAL PROCESSES:

1. CONVECTION
   a. BODY GIVES OFF HEAT TO COOLER SURROUNDING AIR
   b. SURROUNDING AIR BECOMES WARM AND MOVES UPWARD
   c. WARM AIR IS REPLACED WITH COOLER AIR, COMPLETING CONVECTION CYCLE
2. RADIATION
   a. PROCESS WHEREBY HEAT MOVES FROM A HEAT SOURCE TO AN OBJECT BY HEAT RAYS
   b. DOES NOT REQUIRE AIR MOVEMENT TO COMPLETE HEAT TRANSFER
   c. IS AFFECTED BY TEMPERATURE OF SURROUNDING SURFACES RATHER THAN AIR TEMPERATURE

   NOTE: THE BODY EXPERIENCES THE EFFECT OF SUN RADIATION WHEN IT MOVES FROM A SHADY TO A SUNNY AREA
3. EVAPORATION
   a. PROCESS WHERE MOISTURE BECOMES VAPOR
   b. REMOVES HEAT AND THUS COOLS SURFACE
   c. TAKES PLACE CONSTANTLY ON BODY SURFACE
   d. GIVEN OFF THROUGH PORES OF SKIN
   e. PERSPIRATION INDICATES BODY IS PRODUCING MORE HEAT THAN CAN

SHOW TRANSPARENCIES: FIGURES 1, 2, 3, 4

BE REMOVED BY CONVECTION, RADIATION, AND NORMAL EVAPORATION

3. FACTORS THAT AFFECT BODY HEAT

THREE FACTORS THAT AFFECT BODY HEAT ARE:

1. TEMPERATURE
   a. COOL AIR INCREASES RATE OF CONVECTION; WARM AIR SLOWS IT DOWN
   b. COOL AIR INCREASES RATE OF RADIATION; WARM AIR DECREASES RADIATION RATE
   c. COOL AIR INCREASES THE RATE OF EVAPORATION; WARM AIR SLOWS EVAPORATION DOWN

SHOW TRANSPARENCY: FIGURE 5

NOTE: RATE OF EVAPORATION DEPENDS UPON THE AMOUNT OF MOISTURE ALREADY IN THE AIR, AND UPON THE AMOUNT OF AIR MOVEMENT

2. HUMIDITY
   a. MOISTURE IN THE AIR IS MEASURED IN TERMS OF HUMIDITY

NOTE: 50% RELATIVE HUMIDITY MEANS THE AIR CONTAINS ONE-HALF THE AMOUNT OF MOISTURE THAT IT IS CAPABLE OF HOLDING AT A GIVEN TEMPERATURE

   b. LOW RELATIVE HUMIDITY PERMITS HEAT TO BE GIVEN OFF BY EVAPORATION
   c. HIGH RELATIVE HUMIDITY SLOWS DOWN THE EVAPORATION PROCESS THEREBY SLOWING DOWN THE REMOVAL OF HEAT

NOTE: AN ACCEPTABLE COMFORT RANGE FOR HUMAN BEINGS IS 72°-80°F AT 45% - 50% RELATIVE HUMIDITY

3. AIR MOVEMENT
   a. SPEEDS UP REMOVAL OF BODY HEAT
   b. INCREASES CONVECTION PROCESS
   c. ACCELERATES THE RADIATION PROCESS

B. MATTER

DEFINED AS ANYTHING THAT OCCUPIES SPACE AND HAS WEIGHT

1. STATES OF MATTER

THREE BASIC STATES OF MATTER ARE:

SHOW TRANSPARENCY: FIG. 6

1. SOLID
2. LIQUID
3. GAS

2. EFFECTS OF TEMPERATURE

THE EFFECT OF TEMPERATURE ON MATTER ARE:

1. REMOVAL OF HEAT FROM LIQUID WOULD CHANGE TO A SOLID
2. HEAT ADDED TO A LIQUID WOULD CHANGE TO A GAS

3. EXERTION OF PRESSURE

1. LIQUID WILL EXERT PRESSURE OUTWARD AND DOWNWARD
2. GAS EXERTS PRESSURE IN ALL DIRECTIONS
   NOTE: GAS WILL DISSIPATE INTO SURROUNDING AIR IF NOT CONTAINED
3. SOLIDS EXERT PRESSURE DOWNWARD AND WILL HOLD A CERTAIN SHAPE AND SIZE

4. STRUCTURE OF MATTER

MATTER IS MADE UP OF THE FOLLOWING:

1. MOLECULES - SMALLEST PARTICLE OF MATTER MAINTAINING A "STABLE" CONDITION

SHOW TRANSPARENCY: FIG. 7

2. ATOMS - MAKE UP A MOLECULE OF MATTER BUT DO NOT ALWAYS REMAIN STABLE
   NOTE: ATOMS TEND TO JOIN UP WITH OTHER ATOMS TO FORM NEW MOLECULES AND SUBSTANCE
   EXAMPLE: TWO ATOMS OF HYDROGEN COMBINE WITH ONE ATOM OF OXYGEN TO FORM A MOLECULE OF WATER

5. ARRANGEMENT OF MOLECULES

ARRANGEMENT AND MOVEMENT OF MOLECULES

1. MOLECULES IN MATTER ARE CONSTANTLY MOVING
2. MOVEMENT IS CALLED "KINETIC ENERGY"

SHOW TRANSPARENCY: FIGURE 8

3. HEAT CONTROLS THE MOVEMENT OF MOLECULES
   NOTE: IN REMOVING HEAT THE MOLECULAR ACTION IS SPEEDED UP, THEREBY CAUSING A LIQUID TO BOIL

C. HEAT

1. TRANSMISSION OF HEAT

SHOW TRANSPARENCIES: FIGS. 9, 10

TRANSMITTED IN ONE OF THREE WAYS:

1. CONDUCTION - HEAT TRANSFERRED THROUGH A SOLID. EXAMPLE: FRYING MEAT IN A PAN
2. CONVECTION - TRANSFER OF HEAT BY CIRCULATION OF HEATED PORTIONS OF A LIQUID. EXAMPLE: THE AUTOMOBILE COOLING SYSTEM
3. RADIATION - TRANSMISSION OF HEAT WITHOUT HEATING THE MEDIUM
   EXAMPLE: HEAT FROM THE SUN TRANSMITTED THROUGH THE AIR

2. MEASUREMENT OF HEAT

1. HEAT ENERGY IS MEASURED IN TERMS OF THE CALORIE
2. THE GRAM CALORIE IS THE SMALLEST MEASURE OF HEAT ENERGY
3. ONE CALORIE RAISES ONE GRAM OF WATER FROM 15° TO 16°C
4. B.T.U. - BRITISH THERMAL UNIT
5. 252 CALORIES IN ONE B.T.U.
6. ONE B.T.U. WILL RAISE THE TEMPERATURE OF ONE POUND, OR PINT, OF WATER ONE DEGREE FAHRENHEIT
   NOTE: 180 BTU'S ADDED TO ONE POUND OF WATER AT 32°F WILL RAISE WATER TEMPERATURE TO 212°F

3. TYPES OF HEAT

1. SENSIBLE HEAT
   a. CAN BE MEASURED ON THERMOMETER
   b. CAN BE FELT
   c. TEMPERATURE OF AIR THAT SURROUNDS US, AMBIENT TEMPERATURE, IS SENSIBLE HEAT
   d. DROP IN AIR TEMPERATURE PROVIDES COOLER FEELING
   e. INCREASE IN AIR TEMPERATURE PRODUCES WARMER FEELING
2. LATENT HEAT
   a. TERM APPLIED TO HEAT REQUIRED TO CHANGE A STATE OF MATTER
   b. CANNOT BE RECORDED ON A THERMOMETER
   c. LATENT HEAT OF VAPORIZATION — REQUIRED HEAT TO CHANGE ONE

SHOW TRANSPARENCIES: FIGS. 11-12

POUND OF WATER AT 212° TO ONE POUND STEAM AT 212°

NOTE: REQUIRES 970 BTU'S

d. LATENT HEAT OF CONDENSATION - HEAT RELEASED TO CHANGE ONE POUND OF STEAM AT 212°F INTO WATER AT 212°

NOTE: STEAM WILL GIVE UP 970 BTU'S OF HEAT

e. LATENT HEAT OF FUSION - THE AMOUNT OF HEAT REMOVAL REQUIRED TO CHANGE ONE POUND OF WATER AT 32°F TO ONE POUND OF ICE AT 32°F

NOTE: REQUIRES 144 BTU'S

3. BASIC PRINCIPLE FOR AIR CONDITIONING

a. REFRIGERANT HAS THE ABILITY TO ABSORB AND GIVE UP LARGE QUANTITIES OF HEAT RAPIDLY

b. REMOVES HEAT INSIDE THE CAR AND DISSIPATES HEAT OUTSIDE OF CAR

SPECIFIC HEAT (THERMAL HEAT)

a. THE ABILITY TO ABSORB OR EXPEL HEAT

b. EVERY ELEMENT OR COMPOUND HAS ITS OWN CHARACTERISTICS AND ABILITY TO EXPEL HEAT

SHOW TRANSPARENCY: FIG.13

c. THE AMOUNT OF HEAT THAT CAN BE ABSORBED IN ORDER TO UNDERGO A TEMPERATURE CHANGE OF 1°F

d. SCALE DEVISED TO SHOW RELATION OF VARIOUS SUBSTANCES' ABILITY TO ABSORB OR EMIT HEAT

NOTE: WATER IS USED AS THE STANDARD ON THE SCALE AT A VALUE OF $1.00

D. COLD

1. WHAT IS COLD? THE ABSENCE OF HEAT
2. HEAT MUST BE REMOVED IN ORDER TO COOL
3. ABSOLUTE COLD IS THE ABSENCE OF ALL HEAT AND ALL MOLECULAR MOVEMENT IS STOPPED

NOTE: ABSOLUTE COLD HAS NOT BEEN ACCOMPLISHED

E. PRESSURE

DEFINED AS A PRESSURE ACTING AGAINST AN OPPOSING FORCE

1. ATMOSPHERIC PRESSURE

1. 600 MILE BELT OF GAS ENVELOPING THE EARTH
2. ATMOSPHERIC PRESSURE IS MEASURED IN POUNDS PER SQUARE INCH

SHOW TRANSPARENCIES: FIGS. 14-15

3. PRESSURE EXERTED IS 14.7 P.S.I. AT SEA LEVEL
4. GAS BELT CONSISTS OF 78% NITROGEN, 21% OXYGEN AND 17% OTHER GASES
5. PRESSURE ABOVE ATMOSPHERIC PRESSURE IS REFERRED TO AS GAGE PRESSURE

   NOTE: RECORDED AS POUNDS PER SQUARE IN GAGE
6. PRESSURE BELOW ATMOSPHERIC PRESSURE IS REFERRED TO AS A VACUUM

   NOTE: RECORDED AS INCHES OF MERCURY (HG)

2. PRESSURE EFFECT ON TEMPERATURE

1. AT SEA LEVEL THE BOILING POINT OF WATER IS $212^{o}F$
2. ABOVE SEA LEVEL THE ATMOSPHERIC PRESSURE IS LOWER. AS A RESULT THE BOILING POINT OF WATER IS LOWERED
3. THE BOILING POINT OF WATER DECREASES $1.1^{o}F$ PER ONE THOUSAND FEET OF ALTITUDE

   EXAMPLE: AT 12,000 FEET WATER WOULD BOIL AT $198.8^{o}F$

   12,000 FEET $\div$ 1000 = 12

   12 x 1.1^{o}/1000 FEET = $13.2^{o}F$ CHANGE

   $212^{o}F - 13.2^{o}F = 198.8^{o}F$
4. THE INCREASE IN PRESSURE RAISES THE BOILING POINT OF WATER $3^{o}F$ PER POUND OF PRESSURE

   NOTE: THIS IS THE PRINCIPLE OF PRESSURE COOKING, THE AUTOMOTIVE COOLING AND AIR CONDITIONING SYSTEM

   EXAMPLE: A COOLING SYSTEM WITH A 16 P.S.I. PRESSURE CAP WILL INCREASE THE BOILING POINT OF COOLANT IN THE SYSTEM TO ABOUT $233^{o}F$

   16^{o} P.S.I. x $3^{o}F = 21^{o}F$ INCREASE

   $21^{o}F + 212^{o}F = 233^{o}F$

5. TEMPERATURE CAN BE CONTROLLED BY CONTROLLING PRESSURE

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

TRUE OR FALSE

1.	THE DIRECTION OF HEAT FLOW IS FROM A LESS WARM TO A WARM SURFACE.	F
2.	EVAPORATION OF PERSPIRATION IS SLOWER IF THE RELATIVE HUMIDITY OF THE AIR IS LOW.	T
3.	THE BODY PRODUCES MORE HEAT THAN IT NEEDS.	T
4.	THE PHENOMENON OF HEAT FLOWING FROM A HOT SURFACE TO A LESS WARMER SURFACE IS THE PROCESS OF CONVECTION.	T
5.	COOL AIR DECREASES THE RATE OF RADIATION.	F
6.	REMOVAL OF SUFFICIENT HEAT FROM A SOLID CHANGES THE SOLID INTO A LIQUID.	T
7.	SUFFICIENT HEAT ADDED TO A LIQUID WILL PRODUCE A GAS.	T
8.	THE SMALLEST PARTICLE OF MATTER MAINTAINING A STABLE CONDITION IS CALL AN ATOM.	F
9.	THE CONSTANT MOVEMENT OF MOLECULES OF MATTER IS CALLED "KINETIC ENERGY".	T
10.	ONE CALORIE RAISES ONE GRAM OF WATER $1^{o}C$.	T
11.	THE CAPACITY OT EXPEL HEAT OR ABSORB HEAT IS KNOWN AS "LATENT HEAT".	F
12.	ONE B.T.U. WILL RAISE THE TEMPERATURE OF ONE PINT OF WATER $1^{o}F$.	T
13.	THE HEAT REQUIRED TO CHANGE ONE POUND OF WATER INTO ONE POUND OF STEAM AT 212^{o} IS REFERRED TO AS "LATENT HEAT OF VAPORIZATION".	T
14.	COLD IS THE ABSENCE OF HEAT.	T
15.	AS THE ATMOSPHERIC PRESSURE INCREASES, THE BOILING POINT OF WATER DECREASES.	F

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

SIMPLE RECALL QUESTIONS

1.	THE BOILING POINT FOR WATER AT SEA LEVEL IS ____.	$212^{o}F$
2.	THE DECREASE OF ATMOSPHERIC PRESSURE CAUSES THE BOILING POINT OF WATER TO BE ____.	LOWERED
3.	THE AMOUNT OF HEAT REMOVAL REQUIRED TO CHANGE ONE POUND OF WATER AT $32^{o}F$ TO ONE POUND OF ICE AT $32^{o}F$ IS REFERRED TO AS LATENT HEAT OF ____.	FUSION
4.	THE AUTOMOBILE COOLING SYSTEM IS A GOOD EXAMPLE OF ____ COOLING.	CONVECTION
5.	GAS EXERTS PRESSURE IN ____ DIRECTIONS WITH EQUAL FORCE WHEN SEALED IN AN ENCLOSED CONCONTAINER.	ALL
6.	THREE MAIN FACTORS THAT AFFECT BODY HEAT ARE: TEMPERATURE, HUMIDITY AND ____.	AIR MOVEMENT
7.	THERE ARE ____ CALORIES IN ONE BTU.	252
8.	AS AIR MOVEMENT DECREASES, THE EVAPORATION, CONVECTION, AND RADIATION PROCESSES ____.	DECREASE
9.	THE ATMOSPHERIC PRESSURE AT SEA LEVEL IS ____.	14.7 P.S.I.
10.	VACUUM (PRESSURE BELOW ATMOSPHERIC PRESSURE) IS MEASURED OR RECORDED AS INCHES OF ____.	MERCURY

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

FOOD TAKEN IN BY THE BODY CONTAINS HEAT IN THE FORM OF CALORIES, WHICH ARE CONVERTED INTO ENERGY AND STORED FOR USE. THROUGH THIS CONVERSION PROCESS AND BODY MOVEMENT, HEAT IS GENERATED. THIS HEAT MUST BE CONSTANTLY GIVEN OFF OR REMOVED.

THE BODY REJECTS HEAT THROUGH THE PROCESS OF CONVECTION, RADIATION, AND EVAPORATION. FACTORS CONTRIBUTING TO OR HINDERING THE

HEAT REMOVAL AND BODY COMFORT ARE TEMPERATURE, HUMIDITY, AND AIR MOVEMENT.

MATTER IS DEFINED AS ANYTHING THAT OCCUPIES SPACE AND HAS WEIGHT. MATTER IS MADE UP OF MOLECULES AND ATOMS, AND IS FOUND IN THE BASIC STATE OF A LIQUID, SOLID, OR GAS.

MATTER IS AFFECTED BY THE ADDITION OR REMOVAL OF HEAT, IN THAT MATTER WILL CHANGE FROM A SOLID TO A LIQUID WITH THE ADDITION OF HEAT, OR FROM A LIQUID TO A SOLID WITH THE REMOVAL OF HEAT.

HEAT CONTROLS THE MOVEMENTS OF MOLECULES WITHIN MATTER. THIS MOVEMENT OF MOLECULES IS REFERRED TO AS "KINETIC ENERGY".

HEAT IS TRANSMITTED BY THE PROCESS OF CONDUCTION, CONVECTION, OR RADIATION, AND IS MEASURED IN CALORIES. ONE CALORIE OF HEAT IS THE AMOUNT REQUIRED TO RAISE THE TEMPERATURE OF ONE GRAM OF WATER ONE DEGREE CENTIGRADE.

ONE B.T.U. (BRITISH THERMAL UNIT) IS THE MEASUREMENT OF HEAT REQUIRED TO RAISE THE TEMPERATURE OF ONE POUND OF WATER ONE DEGREE FAHRENHEIT. ONE B.T.U. IS EQUAL TO 252 CALORIES.

HEAT, OF WHICH WE HAVE SENSIBLE HEAT, LATENT HEAT, AND SPECIFIC HEAT, IS AFFECTED BY PRESSURE. AT SEA LEVEL, WHERE THE ATMOSPHERIC PRESSURE IS 14.7 LBS. PER SQUARE INCH, WATER WILL BOIL AT 212°F. WHEN THE PRESSURE IS LOWERED, THE BOILING POINT WILL BE LOWERED. IN THE SAME MANNER, WHEN PRESSURE IS INCREASED, THE BOILING POINT OF WATER WILL BE RAISED.

THIS PROCESS OF CONTROLLING TEMPERATURE BY CONTROLLING THE PRESSURE EXERTED ON A COOLANT IS THE BASIC PRINCIPLE OF REFRIGERATION.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646
AUTOMOTIVE MECHANICS, CH. 43
AUTO SERVICE AND REPAIR, CH. 32

THE NEXT LESSON IS: IX-A-2(I) "THE REFRIGERATION CYCLE"

16

INFORMATION SHEET IX-A-2(IS)
ON
REFRIGERANT SYSTEM

SUBJECT: General Safety

INTRODUCTORY INFORMATION:

Many precautions must be observed when servicing any part of the air conditioning system. An understanding of the characteristics of refrigerant 12 is necessary in order to safely service the refrigerant system.

GENERAL SAFETY:

1. Always wear protective safety goggles when servicing the refrigeration system.
2. Should refrigerant come in contact with eyes follow this procedure:
   a. Do not panic
   b. Rinse or splash eyes with cold water
   c. Avoid rubbing eyes
   d. Apply several drops of clean mineral oil to each eye
   e. Consult eye specialist immediately
3. Keep service area well ventilated.
4. Discharge/refrigerant into service area exhaust system, or outside building.
5. Do not subject refrigerant to high temperatures or heat above 125°.
6. Keep refrigerant container upright when charging.
7. Steam cleaning, welding, or bake body finishing is not to be done on or near the air conditioning refrigeration system.
8. Keep refrigerant away from skin. Note: treat the same as eyes if contact is made.
9. Protect refrigerant supply drum valve and safety plug with a screw cap.
10. Avoid inhaling fumes from a flame type torch detector.
11. Keep refrigerant from coming in contact with bright metal parts.

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

IX-A-2(I)

SUBJECT:	THE REFRIGERATION CYCLE
AIM:	THE STUDENT WILL BE ABLE TO EXPLAIN THE PRINCIPLES INVOLVED IN THE REFRIGERATION CYCLE.
TEACHING AIDS:	TRANSPARENCIES I. ED. IX T, FIGURES 16 AND 17
MATERIALS:	CHALKBOARD, OVERHEAD PROJECTOR
REFERENCES:	AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646 AUTOMOTIVE MECHANICS, CH. 43 AUTO SERVICE AND REPAIR, CH. 32 AUTOMOTIVE SERVICE MANUALS
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE LEARNER MUST HAVE READ THE ASSIGNED READING LESSON AND HAVE COVERED PREVIOUS LESSON IX-A-1(I) "BASIC PRINCIPLES OF REFRIGERATION"

I. PREPARATION (OF THE LEARNER - MOTIVATION)

AN AIR CONDITIONING SYSTEM MUST USE THE SAME REFRIGERANT REPEATEDLY IN ORDER FOR THE SYSTEM TO OPERATE ECONOMICALLY. THIS IS PERFORMED BY A CYCLE WITHIN A CLOSED CIRCUIT CONSISTING OF COMPRESSION, CONDENSATION, EXPANSION, AND EVAPORATION. THE REFRIGERANT IS USED TO MOVE HEAT FROM ONE AREA, TO COOL THIS AREA, AND TO EXPEL THIS HEAT IN ANOTHER AREA. THE CYCLE CONSISTS OF FOUR PARTS DIVIDED AT THE CENTER INTO A LOW SIDE (LOW PRESSURE) AND A HIGH SIDE (HIGH PRESSURE). THIS REFERS TO THE PRESSURES OF THE REFRIGERANT IN EACH SIDE OF THE SYSTEM. AS EXPLAINED EARLIER, THE BOILING POINT OF A LIQUID CAN BE VARIED BY CHANGING THE PRESSURE ON THE LIQUID. THIS IS THE PRINCIPLE APPLIED IN THE REFRIGERATION CYCLE.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. FUNCTIONS OF AIR CONDITIONING	1. DEHUMIDIFIES THE AIR 2. PURIFIES THE AIR 3. COOLS THE AIR 4. CIRCULATES THE COOL, CLEAN, AND DEHUMIDIFIED AIR COMING INSIDE THE VEHICLE
B. LAWS OF REFRIGERATION	1. TO REFRIGERATE IS TO COOL NOTE: ABSENCE OF HEAT IS COLD

2. HEAT WILL TRANSFER TO A LOWER TEMPERATURE
3. HEAT IS NEEDED TO CHANGE A LIQUID TO A GAS VAPOR

NOTE: THE HEAT IS CARRIED OFF IN A A GAS VAPOR

NOTE: LIQUID REFRIGERANT IN THE EVAPORATOR TAKES ON HEAT AS IT CHANGES TO A VAPOR

C. PHYSICAL FACTS OF THE REFRIGERATION CYCLE

1. A SUBSTANCE CHANGING FROM A LIQUID TO A VAPOR MUST ABSORB HEAT
2. LIQUID CAN BE STORED AT TEMPERATURES HIGHER THAN THE BOILING POINT IN A CLOSED CONTAINER

SHOW TRANSPARENCIES: FIGS. 16 - 17

3. PRESSURE OF THE SATURATED VAPOR ABOVE THE LIQUID PREVENTS THE LIQUID FROM EVAPORATING
4. WHEN PRESSURE IS REMOVED FROM A LIQUID THAT IS WARMER THAN ITS BOILING TEMPERATURE, IT FLASHES INTO VAPOR AND ABSORBS HEAT
5. THERE IS A DEFINITE RELATIONSHIP BETWEEN TEMPERATURE AND THE PRESSURE OF A SATURATED VAPOR
6. COMPRESSING A VAPOR THAT IS NOT IN CONTACT WITH THE GENERATING LIQUID RAISES THE TEMPERATURE AND PRESSURE OF THE VAPOR
7. HEAT ALWAYS FLOWS FROM HOT TO COLD
8. WHEN ENOUGH HEAT IS REMOVED FROM A VAPOR, IT CONDENSES BACK INTO A LIQUID
9. FOR COOLING TO TAKE PLACE, THE REFRIGERANT MUST CHANGE STATE

D. BASIC REFRIGERATION

FOR AN AIR CONDITIONING SYSTEM TO OPERATE WITH ECONOMY, THE REFRIGERANT MUST BE USED REPEATEDLY. FOR THIS REASON, ALL AIR CONDITIONERS USE THE SAME CYCLE OF COMPRESSION, CONDENSATION, EXPANSION AND EVAPORATION

1. EXPANSION AND VAPORIZATION

1. LIQUID REFRIGERANT IS ABOUT 1/9 THE ORIGINAL PRESSURE AT THE START OF

		THE REFRIGERATION CYCLE
		2. THE REFRIGERANT VAPORIZES READILY AND ABSORBS HEAT FROM EVAPORATOR COILS AND FINS
		3. EVAPORATOR BECOMES COLD AND ABSORBS HEAT FROM AIR BLOWN OVER THE FINS
		4. THE AIR IS COOLED AND WATER VAPOR IN THE AIR IS CONDENSED OUT
		5. AIR BLOWN OVER THE EVAPORATOR FINS COOLS THE PASSENGER COMPARTMENT
		6. FLOW OF REFRIGERANT IS CONTROLLED TO PROVIDE VAPORIZATION THROUGHOUT EVAPORATOR
		7. THE REFRIGERANT IS SLIGHTLY SUPERHEATED WHEN LEAVING THE EVAPORATOR AND ENTERS THE COMPRESSOR
2.	COMPRESSION	1. CIRCULATES THE REFRIGERANT IN THE SYSTEM
		2. THE LOWER PRESSURE VAPOR IS PULLED INTO COMPRESSOR FROM THE EVAPORATOR
		3. COMPRESSION INCREASES THE TEMPERATURE AND PRESSURE OF THE VAPOR
		4. THE VAPOR BECOMES A HIGH PRESSURE VAPOR FORCED INTO THE CONDENSER
3.	CONDENSING THE VAPOR	1. OUTSIDE AIR IS PULLED OVER THE CONDENSER FINS AND REMOVES HEAT FROM THE REFRIGERANT IN THE CONDENSER
		2. REFRIGERANT CONDENSES BACK INTO A LIQUID
4.	DRYING AND STORAGE	1. LIQUID REFRIGERANT IS STORED IN THE RECEIVER-DEHYDRATOR UNTIL NEEDED
		2. MOISTURE IS REMOVED BY A DRYING AGENT
		3. LIQUID REFRIGERANT IS METERED INTO THE EVAPORATOR AS REQUIRED
5.	CONTROL OF REFRIGERANT EXPANSION	1. REFRIGERANT FLOW INTO THE EVAPORATOR IS CONTROLLED BY AN EXPANSION VALVE

2. PROVIDES RESISTANCE FOR THE COMPRESSOR TO PUMP UP AGAINST IN ORDER TO BUILD UP PRESSURE

6. CONTROL SYSTEM

1. CONTROLS THE AMOUNT OF COOLING REQUIRED
2. PROTECTS FROM FREEZING UP ON THE EVAPORATOR
3. CONTROLLED THROUGH STARTING AND STOPPING OF COMPRESSOR
4. MAGNETIC CLUTCH IS OPERATED BY A THERMOSTATIC SWITCH WHICH IS CONTROLLED BY THE TEMPERATURE CONTROL KNOB

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

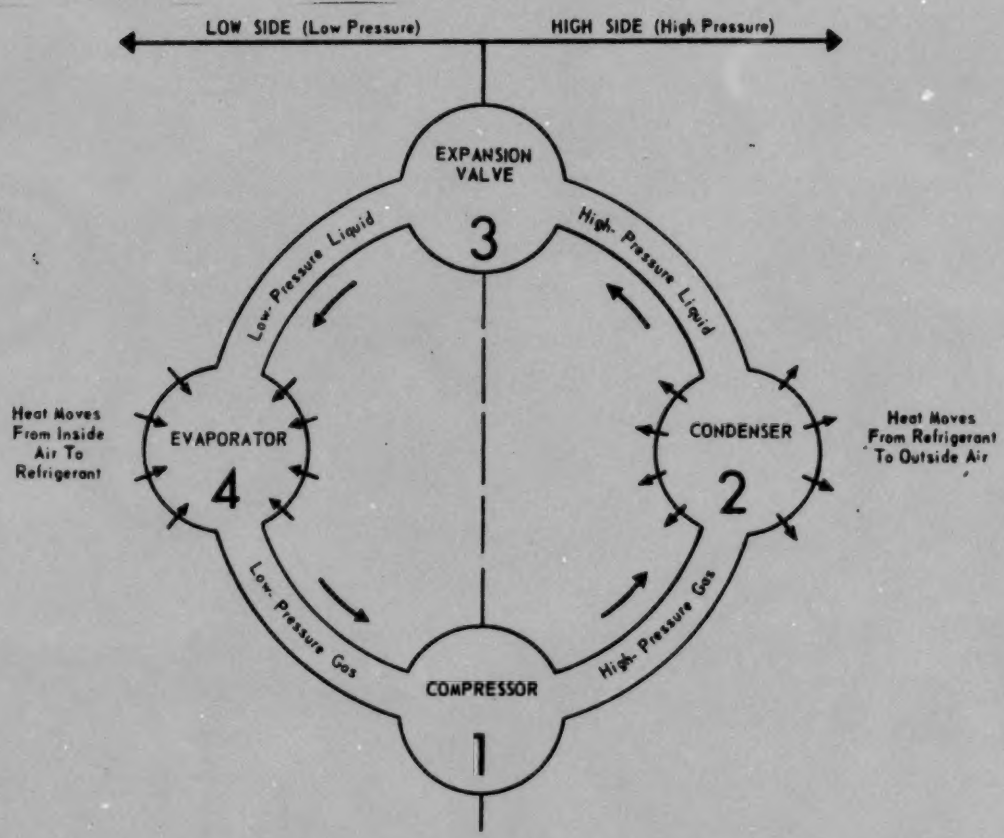
SIMPLE RECALL

1. THE REFRIGERATION CYCLE IS DIVIDED INTO FOUR PARTS: _____, _____, _____, AND _____.	COMPRESSION CONDENSATION EXPANSION EVAPORATION
2. THE FUNCTION OF AIR CONDITIONING IS TO: _____, _____, _____, AND _____.	PURIFY AIR, COOL AIR DEHUMIDIFY THE AIR CIRCULATE THE AIR
3. FLUIDS _____ HEAT WHEN CHANGED FROM A LIQUID TO A GAS.	ABSORB
4. _____ HEATS UP THE GAS.	COMPRESSION
5. _____ CHANGES GAS TO A LIQUID AND RELEASES HEAT.	CONDENSATION
6. _____ REDUCES PRESSURE.	EXPANSION
7. _____ CHANGES LIQUID TO GAS AND ABSORBS HEAT.	EVAPORATION
8. INCREASING THE PRESSURE ON A LIQUID _____ THE BOILING POINT.	RAISES
9. THE ABSENCE OF HEAT IS _____.	COLD
10. THE _____ CONTROLS THE FLOW OF REFRIGERANT INTO THE EVAPORATOR.	EXPANSION VALVE

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

PICTORIAL RECALL TEST ON REFRIGERATION CYCLE

DIRECTIONS: LABEL PARTS 1, 2, 3, AND 4. INDICATE HIGH SIDE AND LOW SIDE BY EACH ARROW AT THE TOP. LABEL THE REFRIGERANT FLOW BETWEEN EACH CYCLE AS TO HIGH OR LOW PRESSURE, AND AS TO GAS OR LIQUID. SHOW WITH ARROWS AROUND PARTS "2" AND "4" WHETHER HEAT IS ABSORBED OR GIVEN OFF.



FOUR-PART CYCLE OF REFRIGERATION

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

FLUIDS WHEN CHANGED FROM A LIQUID TO A GAS, OR FROM A GAS TO A LIQUID, GIVE OFF HEAT. HEAT ALWAYS TRAVELS FROM HOT TO COLD. THE TEMPERATURE AT WHICH A LIQUID CHANGES TO A GAS VARIES WITH THE AMOUNT OF PRESSURE ON IT. IN ORDER FOR THE BEST HEAT EXCHANGE, REFRIGERANT FLUIDS MUST HAVE A LOW BOILING POINT AND BE CAPABLE OF HEATING OR COOLING READILY.

THE REFRIGERATION CYCLE CONSISTS OF FOUR PARTS; NAMELY, COMPRESSION, CONDENSATION, EXPANSION, AND EVAPORATION. THIS CYCLE PERMITS THE AIR CONDITIONING SYSTEM TO OPERATE ECONOMICALLY BY THE RECYCLING PROCESS OF THE REFRIGERANT. THROUGH THE COMPRESSION CYCLE, THE GAS IS HEATED AND CHANGED INTO A HIGH PRESSURE GAS. THE CONDENSATION CYCLE CHANGES THE GAS TO A LIQUID AND RELEASES HEAT. TO CONTROL THE PRESSURE, THE EXPANSION CYCLE REGULATES THE FLOW OF REFRIGERANT, AND THROUGH THE EVAPORATION CYCLE, THE LIQUID IS CHANGED TO A GAS AND ABSORBS HEAT, THEREBY, COMPLETING THE CYCLE OF REFRIGERATION.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646
AUTOMOTIVE MECHANICS, CH. 43
AUTO SERVICE AND REPAIR, CH. 32
AUTOMOTIVE SERVICE MANUALS

THE NEXT LESSON IS: IX-A-3(I) "REFRIGERANTS AND REFRIGERATION OILS"

INFORMATION SHEET IX-A-3(IS)
ON
A/C REFRIGERANT SYSTEM

SUBJECT: Refrigerant Components

INTRODUCTORY
INFORMATION:

Before any refrigeration system can function satisfactorily, all supporting components must be operating to set standards. Failure of any component can cause another component to malfunction. The worst enemy of the refrigerant system is moisture. When the filter-drier no longer functions properly because of saturation, moisture and corrosion particles will collect at the expansion valve and a no cooling condition will be present because of valve freeze-up. When all components are functioning properly, comfortable passenger compartment temperature may be expected.

GENERAL INFORMATION:

When a refrigerant component is removed for repair, adjustment, or replacement, care must be taken to prevent dirt or moisture from entering the system. Replacement filter-drier units must be sealed while in storage. The drier is so hungry for moisture that it can saturate quickly upon exposure to the atmosphere. When installing any component, have all tools and supplies ready for quick installation to avoid keeping the system open any longer than necessary.

The refrigerant system consists of eleven major components:

1. Clutch Pulley and Coil
   a. Mounted on compressor
   b. Provides convenient way to drive and disengage compressor

2. Condenser
   a. Mounted in front of engine radiator
   b. Cools the hot high pressure gas causing it to condense into high pressure liquid refrigerant

3. Filter-Drier
   a. Mounted near the condenser
   b. Is used to remove all traces of moisture from the refrigerant

4. Sight Glass
   a. Incorporated in high pressure line or at top of filter-drier
   b. Provided as diagnostic tool to observe refrigerant flow

5. Evaporator Coil

a. Located in or near passenger compartment
b. Cools and dehumidifies the air before it enters the car

6. Low Pressure Cut Off Switch
   a. Located near compressor or filter-drier
   b. Prevents damage to compressor by breaking circuit continuity, disengaging the clutch, when refrigerant charge becomes low

7. Expansion Valve
   a. Located at the evaporator inlet
   b. Meters refrigerant into the evaporator in accordance to cooling requirements

8. Freeze Control Valve or Switch
   a. Located in compressor or near the evaporator
   b. By-passes the refrigerant gas or disengages the compressor clutch to keep condensed moisture from freezing on the evaporator coil and restricting air flow

9. High Pressure Relief Valve
   a. Located on filter-drier or compressor
   b. A safety device designed to open automatically if the system pressure reaches a predetermined level to prevent system damage

10. Refrigerant Lines
    a. Needed to carry refrigerant between the various system components
    b. Made of materials to withstand high pressure

11. Service Valves
    a. Located on the compressor or low and high pressure lines
    b. Needed to service and test the refrigerant system

INSTRUCTOR'S PLAN IX-A-3(I)
INFORMATIONAL LESSON

SUBJECT:	REFRIGERANTS AND REFRIGERATION OILS
AIM:	THE STUDENT WILL BE ABLE TO EXPLAIN REFRIGERANTS AND REFRIGERANT OILS AS TO TYPES, USE, AND PRECAUTIONS TO BE OBSERVED IN HANDLING
TEACHING AIDS:	TRANSPARENCIES I. ED. IX-T, FIGURES INFORMATION SHEET IX-A-2 (IS) "GENERAL SAFETY"
MATERIALS:	OVERHEAD PROJECTOR, CHALKBOARD
REFERENCES:	AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646 AUTOMOTIVE MECHANICS, CH. 43 AUTO SERVICE AND REPAIR, CH. 32 AUTO SERVICE MANUALS
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST HAVE READ THE ASSIGNED READING LESSON AND HAVE COVERED PREVIOUS LESSONS ON THE REFRIGERATION SYSTEM.

I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE TERM "REFRIGERANT" REFERS TO THE FLUID USED IN THE REFRIGERATION SYSTEM TO PRODUCE "COLD" BY REMOVING HEAT FROM THE AIR.

THE REFRIGERANT USED FOR ALL AUTOMOTIVE SYSTEMS IS CALLED REFRIGERANT 12 (R-12) WHICH WILL MAINTAIN ITS EFFICIENCY INDEFINITELY UNLESS CONTAMINATED WITH DIRT, AIR, OR WATER. R-12 IS NONTOXIC, NONCORROSIVE, ODORLESS, COLORLESS, AND NONFLAMMABLE. HOWEVER, CAUTION SHOULD BE OBSERVED WHEN HANDLING THE REFRIGERANT, AS IT IS IN A LIQUID STATE WHILE UNDER PRESSURE AND WILL VAPORIZE AT -21.7° F. THE REFRIGERANT CAN CAUSE FROSTBITE IF IT CONTACTS THE SKIN. ALSO, CARE SHOULD BE TAKEN TO AVOID USE OF REFRIGERANTS NEAR AN OPEN FLAME, AS THIS WILL PRODUCE THE TOXIC GAS PHOSGENE.

REFRIGERATION OIL IS NEEDED TO LUBRICATE THE SEALS, GASKETS, AND OTHER MOVING PARTS OF THE COMPRESSOR. FOR THIS REASON A SMALL AMOUNT OF SPECIAL NONFOAMING OIL IS CIRCULATED THROUGH THE SYSTEM WITH REFRIGERANT.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. PROPERTIES OF REFRIGERANTS	1. MUST HAVE THE ABILITY TO VAPORIZE EASILY

NOTE: BOILING POINT OF REFRIGERANT MUST BE LOWER THAN FREEZING POINT OF WATER

2. MUST CONDENSE REFRIGERATION VAPOR TO A LIQUID WITHOUT EXCESSIVE PRESSURE
3. MUST HAVE LOW LATENT HEAT OF VAPORIZATION IN ORDER TO CONTROL AND CIRCULATE REFRIGERANT MORE EASILY
4. MUST BE NONCORROSIVE
   NOTE: MATERIALS USED IN THE SYSTEM ARE DETERMINED BY THE CORROSIVENESS OF THE REFRIGERANT
5. REFRIGERANT MUST BE SAFE TO HANDLE AND NONFLAMMABLE OR NONEXPLOSIVE
6. REFRIGERANT MUST BE ODORLESS AND NONTOXIC OR NONPOISONOUS
7. REFRIGERANT MUST BE CHEMICALLY STABLE
8. REFRIGERANT MUST BE COMPATIBLE WITH PETROLEUM OIL
9. MANUFACTURING COST IS AN IMPORTANT FACTOR TO BE CONSIDERED

B. REFRIGERANT 12

REFRIGERANT 12 HAS BEEN ADOPTED FOR AUTOMOTIVE SERVICE BECAUSE OF ITS ABILITY TO WITHSTAND HIGH PRESSURES AND TEMPERATURES WITHOUT DETERIORATING OR DECOMPOSING AND ITS HIGH SAFETY FACTOR

1. COMPOUND NAME IS DICHLORODIFLUOROMETHANE
2. REFERRED TO AS R-12
3. MAINTAINS STABILITY AT HIGH OR LOW OPERATING TEMPERATURES
4. DOES NOT REACT WITH MOST METALS SUCH AS IRON, ALUMINUM, COPPER, OR STEEL
5. NONFLAMMABLE AND NONEXPLOSIVE IN EITHER GAS OR LIQUID FORM
6. HAS NO EFFECT ON THE TASTE, SMELL, OR COLOR OF WATER OR FOOD
7. ODORLESS IN CONCENTRATES OF LESS THAN 20%

NOTE: WHEN DETECTED BY SMELL, IT HAS A SLIGHT ODOR OF ITS ORIGINAL ELEMENT CARBON TETRACHLORIDE

8. NONPOISONOUS EXCEPT IN OPEN FLAME
   CAUTION: GIVES OFF A POISONOUS GAS CALLED PHOSGENE
9. SOLUBLE IN OIL
10. BOILS AT -21.7 DEGREES F.
11. AVAILABLE IN 14 OZ. CANS AND 25 POUND CYLINDERS

SHOW TRANSPARENCY: FIG. 18

12. PRESSURE STAYS IN CLOSE PROXIMITY TO ITS TEMPERATURE FROM 20 TO 80 PSI

C. SAFETY PRECAUTIONS

UNDER MOST CONDITIONS, REFRIGERANT 12 IS PERFECTLY SAFE, BUT FOR PERSONAL SAFETY AND TO AVOID DAMAGE, CERTAIN PRECAUTIONS SHOULD BE OBSERVED

1. REFRIGERANT CONTAINER SHOULD NOT BE OVERHEATED
   CAUTION: REFRIGERANT PRESSURE FROM HEAT WILL CAUSE CONTAINER TO EXPLODE
2. LIQUID REFRIGERANT PERMITTED TO GET IN EYES CAN CAUSE BLINDNESS
   CAUTION: ALWAYS WEAR EYE SAFETY PROTECTION
   NOTE: SHOULD R-12 COME IN CONTACT WITH EYES:
   a. DO NOT RUB EYES
   b. SPLASH COOL WATER IN EYES
   c. TAPE ON STERILE PATCH
   d. SEEK MEDICAL ASSISTANCE
   CAUTION: DO NOT ATTEMPT TO TREAT YOURSELF
3. REFRIGERANT ALLOWED TO COME IN CONTACT WITH OPEN FLAME PRODUCES POISONOUS PHOSGENE GAS
4. LIQUID REFRIGERANT CAUSES FROSTBITE WHEN IN CONTACT WITH SKIN
5. DISCHARGE R-12 IN WELL VENTILATED AREA
   CAUTION: RELEASED IN A CONFINED PLACE CAN CAUSE DROWSINESS

6. CONTAINERS SHOULD BE HANDLED WITH CARE TO AVOID RUPTURE
7. DO NOT APPLY DIRECT FLAME TO R-12 CONTAINER
8. DISCHARGE REFRIGERANT SLOWLY WHEN PURGING SYSTEM
9. DO NOT USE ANYTHING BUT PURE R-12 AND REFRIGERANT OIL IN THE SYSTEM
10. DO NOT HANDLE DAMP R-12 CONTAINERS WITH BARE HANDS WHILE CHARGING A SYSTEM

D. REFRIGERANT OILS

1. HIGHLY REFINED MINERAL OIL
   NOTE: IMPURITIES SUCH AS WAX, MOISTURE, AND SULPHUR ARE REMOVED
   CAUTION: NEVER USE MOTOR OIL
2. REFRIGERANT OIL IS NONFOAMING
3. AVAILABLE IN SEVERAL GRADES OR VISCOSITIES
   NOTE: THE MOST COMMON VISCOSITIES ARE 300, 525, AND 1000
   NOTE: THE LOWER THE VISCOSITY NUMBER THE THINNER THE OIL

E. HANDLING REFRIGERATION OIL

1. NEVER ALLOW THE OIL CONTAINER TO REMAIN UNCAPPED
2. KEEP CAP IN PLACE AND TIGHT
   CAUTION: OIL ABSORBS MOISTURE AND IS DAMAGING TO THE SYSTEM
3. USE ONLY APPROVED REFRIGERATION OIL
4. REFRIGERATION OIL SHOULD NOT BE TRANSFERRED FROM ONE CONTAINER TO ANOTHER
5. DO NOT RETURN OIL FROM A SYSTEM TO A CONTAINER - DISCARD OIL
6. REPLACE OIL IF THERE IS ANY DOUBT ABOUT ITS CONDITION
7. AVOID CONTAMINATION OF OIL
8. CHECK OIL LEVEL OF THE COMPRESSOR EACH TIME SYSTEM IS SERVICED
   NOTE: USE MANUFACTURER'S RECOMMENDATION ON THE GRADE OF REFRIGERANT OIL

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

TRUE OR FALSE

1.	FLUID USED IN THE AUTOMOTIVE AIR CONDITIONER IS CALLED FREON.	F
2.	THE MOST POPULAR SOURCE OF R-12 IS IN 14 OUNCE CANS.	T
3.	AN OPEN CONTAINER OF REFRIGERANT-12 WILL NOT BOIL AT ROOM TEMPERATURE.	F
4.	A GOOD GRADE OF MOTOR OIL IS USED IN THE AIR CONDITIONING SYSTEM.	F
5.	REFRIGERANT OIL AIDS IN KEEPING THE THERMOSTATIC EXPANSION VALVE OPERATING PROPERLY.	T
6.	REFRIGERANT OIL WILL ABSORB MOISTURE IF THE OIL CONTAINER CAP IS NOT ON OR IS LOOSE.	T
7.	SINCE R-12 IS ODORLESS, COLORLESS, NONFLAMMABLE, AND NONCORROSIVE, IT IS HARMLESS.	F
8.	REFRIGERANTS MUST HAVE THE ABILITY TO CONDENSE REFRIGERATION VAPORS INTO LIQUID WITHOUT EXCESSIVE PRESSURE.	T
9.	PHOSGENE IS A GAS PRODUCED BY SUBJECTING A REFRIGERANT TO AN OPEN FLAME.	T
10.	ESCAPING REFRIGERANT THAT MAY COME IN CONTACT WITH THE EYE CAN RESULT IN SERIOUS FROSTBITE OR BLINDNESS.	T

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

SIMPLE RECALL

1.	R-12 BOILS AT _____ F.	- 21. 7°
2.	R-12, WHEN DETECTED BY SMELL, GIVES OFF THE ODOR OF _____ _____.	CARBON TETRACHLORIDE
3.	FOUR GOOD QUALITIES OF R-12 ARE: _____, _____, _____, AND _____ - EXCEPT IN OPEN FLAME.	NONCORROSIVE NONFLAMMABLE NONEXPLOSIVE NONPOISONOUS

4.	REFRIGERATION OIL IS A HIGHLY REFINED _____ OIL.	MINERAL
5.	THE HIGHER THE VISCOSITY NUMBER OF A REFRIGERATION OIL, THE _____ THE OIL.	THICKER
6.	MOISTURE IN THE REFRIGERATION SYSTEM WILL CAUSE _____ OF THE METAL PARTS.	CORROSION
7.	ONE CHARACTERISTIC OF R-12 IS THAT ITS _____ STAYS IN CLOSE PROXIMITY TO ITS _____ FROM 20 TO 80 PSI.	PRESSURE TEMPERATURE
8.	ALWAYS WEAR _____ _____ WHEN WORKING WITH R-12.	EYE PROTECTION
9.	R-12 RELEASED IN A CONFINED AREA CAN CAUSE _____ ON THE PART OF THE INDIVIDUAL.	DROWSINESS
10.	WHEN PURGING A SYSTEM, THE REFRIGERANT IS PURGED _____.	SLOWLY

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

R-12 IS AN IDEAL REFRIGERANT BECAUSE IT IS NONFLAMMABLE, NONEXPLOSIVE, COLORLESS, NONPOISONOUS EXCEPT IN AN OPEN FLAME, AND CAN BE REUSED REPEATEDLY. ALTHOUGH R-12 HANDLED PROPERLY IS SAFE, CERTAIN PRECAUTIONS MUST BE OBSERVED TO PREVENT INJURY. ONE CHARACTERISTIC OF R-12 IS THE RELATIONSHIP BETWEEN PRESSURE AND TEMPERATURE THAT PERMITS THE PRESSURE, BETWEEN 20 AND 80 PSI, TO STAY IN CLOSE PROXIMITY TO THE TEMPERATURE.

REFRIGERANT OIL IS A HIGHLY REFINED MINERAL OIL SPECIFICALLY FOR AIR CONDITIONING SYSTEMS. REFRIGERANT OILS ARE NEEDED TO LUBRICATE SEALS, GASKETS, AND OTHER PARTS OF THE COMPRESSOR. THE THERMOSTATIC EXPANSION VALVE IS KEPT IN PROPER WORKING CONDITIONS BY THE USE OF REFRIGERANT OIL. CARE IN USE AND STORAGE IS VERY IMPORTANT TO PROTECT THE OIL FROM CONTAMINATION AND MOISTURE.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646
AUTOMOTIVE MECHANICS, CH. 43
AUTO SERVICE AND REPAIR, CH. 32

THE NEXT LESSON IS: IX-A-4(I), "AIR CONDITIONING REFRIGERATION SYSTEM MAJOR COMPONENTS"

INSTRUCTOR'S PLAN IX-A-4(I)
INFORMATIONAL LESSON

SUBJECT:	AIR CONDITIONING REFRIGERANT SYSTEM MAJOR COMPONENTS
AIM:	THE STUDENT WILL BE ABLE TO IDENTIFY THE BASIC COMPONENT PARTS IN THE REFRIGERANT SYSTEM, AND BE ABLE TO EXPLAIN THE FUNCTION, OPERATION, AND SELECTION OF EACH COMPONENT PART
TEACHING AIDS:	TRANSPARENCIES I. ED. IX T, FIGURES 19-23 INFORMATION SHEET IX-A-3(IS), "REFRIGERATION COMPONENTS"
MATERIALS:	OVERHEAD PROJECTOR, CHALKBOARD, MANUFACTURER CHART, SAMPLES OF COMPONENT PARTS
REFERENCES:	AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646 AUTOMOTIVE MECHANICS, CH. 43 AUTO SERVICE AND REPAIR, CH. 32 AUTOMOTIVE SERVICE MANUALS
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST HAVE READ ASSIGNED READING LESSON AND HAVE COMPLETED PREVIOUS LESSONS ON THE REFRIGERATION SYSTEM

I. PREPARATION (OF THE LEARNER - MOTIVATION)

ALL AIR CONDITIONING SYSTEMS MUST HAVE FOUR BASIC COMPONENTS: (1) COMPRESSOR, (2) CONDENSER, (3) EXPANSION VALVE, AND (4) EVAPORATOR. FROM THE COMPRESSOR, HIGH PRESSURE GAS IS SENT TO THE CONDENSER, WHERE IT IS CONVERTED TO A LIQUID AND HEAT IS DISSIPATED. THE HIGH PRESSURE LIQUID FLOWS ON TO THE EXPANSION VALVE, WHERE IT IS METERED AND ITS PRESSURE REDUCED. AT THE EVAPORATOR, THE LIQUID IS AGAIN CONVERTED TO GAS, ABSORBING HEAT FROM THE AIR. THE CYCLE IS THEN REPEATED, STARTING AT THE COMPRESSOR.

THE AIR CONDITIONER IS A HEAT TRANSFER UNIT. A FAILURE OF ANY COMPONENT WILL INTERRUPT THE HEAT EXCHANGE CYCLE AND CAUSE THE WHOLE SYSTEM TO FAIL. EACH COMPONENT IS DESIGNED AND BALANCED TO OTHER PARTS OF THE SYSTEM IN ORDER TO MOVE HEAT FROM THE INSIDE AIR TO THE AIR OUTSIDE, WHERE IT IS DISSIPATED.

IN ORDER TO PROPERLY MAINTAIN AND SERVICE THE AIR CONDITIONER, A COMPLETE UNDERSTANDING OF THE COMPONENTS AS TO TYPES, FUNCTION, AND OPERATION, IS NECESSARY.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. COMPRESSOR SHOW TRANSPARENCY: FIGURES 19-20	THE COMPRESSOR CIRCULATES THE REFRIGERANT IN THE SYSTEM UNDER PRESSURE, THEREBY CONCENTRATING THE HEAT IT CONTAINS
1. OPERATION	1. DRAWS IN LOW PRESSURE VAPOR 2. COMPRESSES LOW PRESSURE VAPOR INTO HIGH PRESSURE VAPOR NOTE: THIS IS ACCOMPLISHED BY HAVING A RESTRICTION IN THE HIGH PRESSURE SIDE OF THE SYSTEM LOCATED IN THE EXPANSION VALVE
2. REED VALVES	1. REED VALVES CONTROL THE ENTRANCE AND EXIT OF REFRIGERANT GAS DURING PUMPING OPERATION 2. IMPROPERLY SEATED INTAKE REED VALVE CAN RESULT IN GAS LEAKING BACK INTO THE LOW SIDE DURING COMPRESSION STROKE 3. A BADLY SEATED DISCHARGE REED VALVE CAN ALLOW CONDENSING OR HEAD PRESSURE TO DROP AS IT LEAKS PAST THE VALVE, LOWERING THE EFFICIENCY OF THE CONDENSER
3. SERVICE VALVES	1. TWO VALVES LOCATED ON OUTSIDE OF COMPRESSOR 2. AID IN SERVICING SYSTEM 3. PROVIDED WITH FITTING FOR ATTACHING THE TEST GAUGE HOSES 4. HIGH SIDE VALVE IS ROUTED TO THE EVAPORATOR NOTE: SOME COMPRESSORS INCORPORATE A SCHRADER VALVE TO HOLD THE REFRIGERANT WHEN A TEST HOSE IS NOT CONNECTED TO THE SERVICE VALVE
4. COMPRESSOR RELIEF VALVE	1. USED TO REGULATE THE SYSTEM DISCHARGE PRESSURE 2. VALVE OPENS AUTOMATICALLY AND STAYS OPEN WHEN PRESSURE EXCEEDS RATED PSI 3. VALVE CLOSES AUTOMATICALLY 4. ON OPENING OF RELIEF VALVE, A LOUD

		POPPING NOISE WILL BE HEARD
		5. SOME OIL MAY BE EJECTED
	5. TYPES OF COMPRESSORS	1. TWO-PISTON, CRANKSHAFT CONTROLLED RECIPROCATING TYPE NOTE: PISTON COMPRESSES VAPOR ON UPSTROKE ONLY
		2. MULTI - AXIAL PISTON - SWASHPLATE CONTROLLED TYPE NOTE: SWASHPLATE FORCES THE PISTIONS TO MOVE BACK AND FORTH
	6. COMPRESSOR SERVICE POINTS	1. CRANKSHAFT REPLACEABLE CARBON-TYPE SEAL
		2. GASKET AT OPPOSITE, OR OIL PUMP, END OF UNIT
		3. REED VALVES AND HEAD GASKETS
B.	CONDENSER SHOW TRANSPARENCY: FIGURE 21	THE PURPOSE OF THE CONDENSER IS TO RECEIVE THE HIGH PRESSURE GAS FROM THE COMPRESSOR AND CONVERT THIS GAS TO A LIQUID
	1. OPERATION	1. BASED ON PRINCIPLE OF HEAT TRANSFER
		2. AIR PASSES OVER THE CONDENSER COILS TO CARRY OFF THE HEAT CAUSING THE GAS TO CONDENSE
		3. TEMPERATURE OF THE REFRIGERANT IS HIGHER THAN THE AMBIENT TEMPERATURE OF THE AIR PASSING OVER CONDENSER COILS
	2. TYPE CONDENSER	1. RAM AIR CONDENSERS ARE USED FOR AUTOMOTIVE SYSTEMS
		2. MOUNTED IN FRONT OF RADIATOR
		3. DEPENDS ON VEHICLE MOVEMENT TO FORCE A LARGE VOLUME OF AIR PAST CONDENSER FINS AND COILS
		4. ENGINE FAN IS USED TO INCREASE AIR VOLUME AT LOWER SPEEDS
		5. CLUTCH - TYPE FAN PERMITS FAN BLADES TO FREE-WHEEL AT HIGHER SPEEDS TO AVOID BLADE DRAG
		6. FAN CLUTCH ENGAGES TO INCREASE AT LOWER SPEEDS
		7. FORCED AIR CONDENSERS ARE USED FOR OFF THE ROAD MACHINES NOTE: USE ELECTRIC FANS TO MOVE AIR

3. CONDENSER PRESSURE

1. NORMAL - PRESSURE MAINTAINED HIGH ENOUGH TO CREATE A WIDE TEMPERATURE DIFFERENTIAL BETWEEN THE HEAT - LADEN REFRIGERANT VAPOR AND THE HOT AIR PASSING OVER THE CONDENSER
2. TOO HIGH CONDENSER PRESSURE
   a. INDICATED BY EXCESSIVE HEAD PRESSURE ON HIGH SIDE GAUGE
   b. CAUSED BY RESTRICTION OF REFRIGERANT FLOW IN HIGH SIDE OF SYSTEM OR LACK OF AIR FLOW OVER CONDENSER COILS
   c. POOR CONDENSING ACTION RESULTS

   NOTE: TWO - THIRDS OF CONDENSER COILS REMOVE HEAT FROM REFRIGERANT VAPOR, WHILE LOWER THIRD CONTAINS LIQUID

   NOTE: TOO HIGH CONDENSING PRESSURE UPSETS THIS BALANCE, ALLOWING SUPERHEATED VAPOR TO ENTER LIQUID HOSE AND THE EXPANSION VALVE
3. TOO LOW CONDENSER PRESSURE
   a. INDICATED BY HIGHER THAN NORMAL PRESSURE ON LOW SIDE GAUGE
   b. CAUSED BY FAILURE OF COMPRESSOR REED VALVE OR PISTON
   c. LOSS OF HEAT EXCHANGE IN THE CONDENSER WILL RESULT AND EXCESSIVE HEAT WILL REMAIN IN THE LOW SIDE OF THE SYSTEM

C. EXPANSION VALVE SHOW TRANSPARENCY: FIGURE 22

THE EXPANSION VALVE REMOVES PRESSURE FROM THE LIQUID REFRIGERANT TO ALLOW EXPANSION OR CHANGE OF STATE FROM A LIQUID TO A VAPOR IN THE EVAPORATOR

1. OPERATION

1. DEPENDS ON THE TEMPERATURE OF THE REFRIGERANT LEAVING THE EVAPORATOR AND THE PRESSURE INSIDE THE EVAPORATOR
2. HIGH PRESSURE LIQUID REFRIGERANT ENTERING THE EXPANSION VALVE IS QUITE WARM

3. REFRIGERANT FLOW IS RESTRICTED BY METERED ORIFICE WHICH IT PASSES THROUGH
   NOTE: REFRIGERANT CHANGES FROM A HIGH PRESSURE LIQUID TO A LOW PRESSURE LIQUID
4. VALVE OPENING DEPENDS ON THE RELATIVE STRENGTH OF THE PRESSURE AND TEMPERATURE SIGNALS
   NOTE: EVAPORATOR PRESSURE, TENDING TO CLOSE VALVE, ACTS DIRECTLY ON THE EXPANSION VALVE DIAPHRAGM, CAUSING IT TO OPEN OR CLOSE
   NOTE: THE TEMPERATURE SIGNAL COMES FROM A TEMPERATURE - SENSING BULB CLIPPED TO THE EVAPORATOR OUTLET
   CAUTION: THE EXPANSION VALVE IS THE MOST SENSITIVE PART IN THE SYSTEM

2. TYPES OF EXPANSION VALVES

1. INTERNAL - EQUALIZED EXPANSION VALVE
   a. MOST COMMON CONTROL
   b. CONTAINS INTERNAL EQUALIZING PASSAGE
   NOTE: OPERATION PREVIOUSLY DESCRIBED IN EXPANSION VALVE OPERATION
2. EXTERNAL - EQUALIZED EXPANSION VALVE
   a. EVAPORATOR PRESSURE IS FED AGAINST THE UNDERSIDE OF THE DIAPHRAGM FROM THE TAIL PIPE OF EVAPORATOR BY AN EQUALIZER LINE
   b. THE TEMPERATURE OF THE TAIL PIPE IS BALANCED THROUGH THE EXPANSION VALVE THERMAL BULB AGAINST THE EVAPORATOR PRESSURE TAKEN FROM THE TAIL PIPE
   NOTE: THIS TYPE VALVE CONTROL IS SPECIALIZED

D. EVAPORATOR
SHOW TRANSPARENCY: FIGURE 23

SERVES AS A HEAT EXCHANGER TO TRANSFER HEAT FROM THE AIR IN THE

PASSENGER COMPARTMENT TO THE VAPORIZING REFRIGERANT

1. CONSTRUCTION
   1. SEVERAL (3 OR 4) ROWS OF COPPER COOLING COILS
   2. CLOSED SPACED ALUMINUM FINS PROVIDE MAXIMUM SURFACE FOR TRANSFERRING HEAT
   3. EVAPORATOR HOUSING SERVES AS A DUCT FOR THE COOLED AIR
   4. WATER-COLLECTING PAN WITH DRAIN HOSE AND TUBE IN THE HOUSING UNDER THE EVAPORATOR TO REMOVE CONDENSED MOISTURE
2. OPERATION
   1. REFRIGERANT LIQUID IS CONVERTED TO GAS AND ABSORBS HEAT FROM THE AIR
   2. LIQUID REFRIGERANT PRESSURE HAS BEEN REDUCED, THEREBY DISSIPATING ITS HEAT CONTENT AND MAKING IT COOLER THAN THE AIR AROUND IT
   3. REFRIGERANT ABSORBS HEAT FROM THE WARM AIR AND REACHES ITS BOILING POINT RAPIDLY, THEREBY VAPORIZING AND ABSORBING THE MAXIMUM AMOUNT OF HEAT
   4. REFRIGERANT, AS A LOW PRESSURE GAS, IS CARRIED TO THE LOW SIDE OF THE COMPRESSOR AND THE CYCLE IS REPEATED
3. BLOWER FAN
   1. DRAWS LARGE VOLUME OF AIR THROUGH EVAPORATOR COILS FOR HEAT EXCHANGE
   2. FORCES THE AIR OVER EVAPORATOR FINS AND COILS
   3. FORCES COOLED AIR INTO SPACE BEING COOLED
   4. FAN BLOWER SPEED REGULATES AND CONTROLS THE COOLING OF THE EVAPORATOR

      NOTE: FOR COLDEST AIR TEMPERATURE FROM THE EVAPORATOR, THE BLOWER FAN IS OPERATED AT THE LOWEST SPEED
4. EVAPORATOR COIL PROBLEMS
   1. STARVED EVAPORATOR COIL
      a. INSUFFICIENT REFRIGERANT SUPPLIED THROUGH THE TOTAL

LENGTH

b. EXPANSION OF REFRIGERANT THROUGH THE WHOLE COIL LENGTH DOES NOT OCCUR
c. RESULTS IN POOR COIL OPERATION AND TOO LOW HEAT EXCHANGE
d. TOO LITTLE AIR EMITTED FROM THE EVAPORATOR
e. TOO LOW READING RESULTS ON THE COMPOUND GAGE
f. TOO QUICK FROST FORMATION ON THE FINS

2. FLOODED EVAPORATOR COIL
   a. TOO MUCH REFRIGERANT IS PASSED THROUGH EVAPORATOR COIL
   b. RESULTS IN UNEXPANDED LIQUID PASSING IN THE SUCTION LINE AND INTO THE COMPRESSOR

   NOTE: LIQUID REFRIGERANT IN THE COMPRESSOR CAN RESULT IN DAMAGE TO THE REED VALVES AND PISTONS
   c. PRODUCES INEFFICIENT HEAT ABSORPTION IN THE EVAPORATOR COIL
   d. LACK OF EVAPORATION RESULTS IN POOR EVAPORATOR COOLING
   e. TOO HIGH PRESSURE READING ON THE COMPOUND GAGE RESULTS
   f. CAUSES EXCESSIVE SWEATING OF THE EVAPORATOR COILS AND SUCTION HOSE
   g. VERY LITTLE COOLING RESULTS

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

TRUE OR FALSE

1. HEAT IS NEEDED TO CHANGE A GAS TO A LIQUID. F
2. THE COMPRESSOR PUMPS LIQUID REFRIGERANT THROUGH THE AIR CONDITIONING SYSTEM. F
3. UPON LEAVING THE COMPRESSOR THE REFRIGERANT ENTERS THE CONDENSER. T

4.	THE EXPANSION VALVE METERS THE REFRIGERANT INTO THE EVAPORATOR.	T
5.	THE REFRIGERANT ENTERS THE COMPRESSOR ON THE LOW SIDE AS A HIGH PRESSURE VAPOR.	F
6.	THE ENTERING AND EXIT OF REFRIGERANT FROM COMPRESSOR IS CONTROLLED BY REED VALVES.	T
7.	GAS LEAKING BACK INTO THE LOW SIDE OF THE COMPRESSOR DURING THE COMPRESSION STROKE INDICATES AN IMPROPERLY SEATED INTAKE REED VALVE.	T
8.	THE HIGH SIDE SERVICE VALVE IS ROUTED TO THE EVAPORATOR.	F
9.	THE OUTLET SIDE OF THE EXPANSION VALVE WILL BE COLD.	T
10.	AIR PASSING OVER CONDENSER COILS CARRY OFF HEAT.	T
11.	RAM AIR IS NATURAL AIR FLOW FROM THE VEHICLE MOVEMENT.	T
12.	AIR PASSING OVER THE EVAPORATOR COILS CHANGES THE REFRIGERANT LIQUID TO A VAPOR.	F
13.	THE EXPANSION VALVE IS CONSIDERED THE MOST SENSITIVE PART OF THE REFRIGERATION SYSTEM.	T
14.	UNEXPANDED LIQUID REFRIGERANT IN THE SUCTION LINE IS A RESULT OF A STARVED EXPANSION COIL.	F
15.	A FLOODED EVAPORATOR COIL OCCURS WHEN TOO MUCH REFRIGERANT IS PASSED THROUGH THE EVAPORATOR COIL.	T

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

SIMPLE RECALL

1.	THE REFRIGERANT IS CIRCULATED IN THE SYSTEM UNDER PRESSURE BY THE _____.	COMPRESSOR
2.	A BADLY SEATED _____ VALVE ALLOWS HEAD PRESSURE TO DROP AND LOWERS THE EFFICIENCY OF THE CONDENSER.	DISCHARGE REED
3.	REFRIGERANT IS METERED INTO THE EVAPORATOR BY THE _____.	EXPANSION VALVE
4.	FOR AUTOMOTIVE REFRIGERANT SYSTEMS, THE _____ CONDENSER IS MOST COMMONLY USED.	RAM AIR

5.	A CLUTCH-TYPE FAN PERMITS THE FAN BLADES TO _____ AT HIGH SPEEDS.	FREE-WHEEL
6.	TOO _____ CONDENSER PRESSURE IS CAUSED BY EXCESSIVE HEAD PRESSURE ON THE HIGH SIDE GAUGE.	HIGH
7.	AIR, BEFORE IT ENTERS THE PASSENGER COMPARTMENT, IS COOLED AND DEHUMIDIFIED BY THE _____.	EVAPORATOR
8.	DAMAGE TO THE COMPRESSOR REED VALVE IS A RESULT OF _____ REFRIGERANT IN THE COMPRESSOR.	LIQUID
9.	THE FOUR BASIC COMPONENTS OF THE REFRIGERATION SYSTEM ARE: THE _____, _____, _____, AND _____.	COMPRESSOR CONDENSER EXPANSION VALVE EVAPORATOR
10.	THE FLOW OF REFRIGERANT GAS INTO AND OUT OF THE COMPRESSOR IS CONTROLLED BY _____.	REED VALVES

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

MOST AUTOMOTIVE AIR CONDITIONING SYSTEMS HAVE BASICALLY THE SAME COMPONENTS. THE BASIC COMPONENTS ARE THE COMPRESSOR, CONDENSER, EXPANSION VALVE, AND EVAPORATOR.

AS A HEAT TRANSFER UNIT, THE FAILURE OF ANY COMPONENT PART OF THE AIR CONDITIONER WILL INTERRUPT THE HEAT EXCHANGE CYCLE AND CAUSE THE WHOLE SYSTEM TO FAIL.

EACH COMPONENT PART PLAYS AN IMPORTANT ROLE IN THE REFRIGERATION SYSTEM.

1. COMPRESSOR
   a. CIRCULATES THE REFRIGERANT THROUGH THE SYSTEM UNDER PRESSURE
   b. CHANGES LOW PRESSURE GAS TO HIGH PRESSURE GAS
2. CONDENSER
   a. RECEIVES HIGH PRESSURE GAS FROM THE COMPRESSOR
   b. CONVERTS HIGH PRESSURE GAS TO A HIGH PRESSURE LIQUID
3. EXPANSION VALVE
   a. METERS THE REFRIGERANT INTO THE EVAPORATOR

b. REMOVES PRESSURE FROM THE LIQUID REFRIGERANT TO ALLOW EXPANSION OR CHANGE OF STATE FROM A LIQUID TO A VAPOR IN THE EVAPORATOR

4. EVAPORATOR
   a. COOLS AND DEHUMIDIFIES THE AIR
   b. LIQUID REFRIGERANT IS CONVERTED TO GAS

THE UNDERSTANDING OF THE FUNCTION AND OPERATION OF THE REFRIGERATION SYSTEM IS ESSENTIAL TO THE PROPER SERVICE AND MAINTENANCE OF THE SYSTEM.

SUGGESTED READING FOR THE STUDENT:

SERVICE MANUALS: AIR CONDITIONING SECTIONS
GENERAL MOTORS
FORD MOTOR COMPANY
CHRYSLER CORPORATION

THE NEXT LESSON IS: IX-A-5(I) "AIR CONDITIONING REFRIGERANT SYSTEM MINOR COMPONENTS"

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

IX-A-5(I)

SUBJECT: AIR CONDITIONING REFRIGERANT SYSTEM MINOR COMPONENTS

AIM: THE STUDENT WILL BE ABLE TO EXPLAIN THE FUNCTION AND OPERATION OF THOSE MINOR COMPONENTS OF THE AIR CONDITIONING SYSTEM AND BE ABLE TO IDENTIFY PROBLEMS THAT MAY OCCUR WITHIN EACH COMPONENT AND ITS EFFECT ON THE SYSTEM.

TEACHING AIDS: CHARTS, COMPONENT PARTS, OVERHEAD PROJECTOR, AND TRANSPARENCIES I. ED IX T FIGURES 24 - 34

MATERIALS: CHALKBOARD

REFERENCES: SERVICE MANUALS: CHRYSLER, GENERAL MOTORS, AND FORD
FUNDAMENTALS OF SERVICE - AIR CONDITIONING, DEERE AND COMPANY, PP. 24 -32
AUTOMOTIVE AIR CONDITIONING, DELMAR PUBLISHERS, PP. 38 - 60

I. PREPARATION (OF THE LEARNER - MOTIVATION)

IN PREVIOUS LESSONS ON THE MAJOR COMPONENTS OF THE AIR CONDITIONING SYSTEM, IT WAS FOUND THAT UNDER CONSTANT LOADS AND CONDITIONS THESE COMPONENTS WORK WELL. IT WOULD BE UNREALISTIC TO BELIEVE THAT THESE CONDITIONS NEVER CHANGE. WHAT EFFECT DOES MOISTURE IN THE REFRIGERANT HAVE ON THE SYSTEM? HOW CAN IT BE CONTROLLED? WHAT METHOD IS USED TO CONTROL EVAPORATOR TEMPERATURE TO KEEP THE EVAPORATOR FROM ICING UP? HOW IS THE OPERATION OF THE COMPRESSOR CONTROLLED? WHAT IS USED TO CARRY THE REFRIGERANT TO EACH MAJOR COMPONENT OF THE REFRIGERATION SYSTEM? THE ANSWERS TO THESE QUESTIONS LIE IN MINOR COMPONENT PARTS OF THE SYSTEM.

THESE MINOR COMPONENTS ARE VITAL TO THE PERFORMANCE OF THE REFRIGERATION SYSTEM. IN THIS LESSON WE WILL IDENTIFY THESE PARTS AND THEIR ROLE IN THE AIR CONDITIONING REFRIGERATION SYSTEM.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. RECEIVER-DRIER (DEHYDRATOR)	AIR CONDITIONING SYSTEMS DO NOT OPERATE AT 100% EFFICIENCY. OVER A PERIOD OF TIME PROBLEMS ARISE, SUCH AS LEAKS OR THE DEMAND FOR

SHOW TRANSPARENCY: FIGURE 24

REFRIGERANT BY THE EVAPORATOR DUE TO CHANGES IN HEAT LOAD, CONDENSING ACTION, AND PUMP SPEED. THE RECEIVER-DRIER IS PROVIDED IN THE SYSTEM TO COMPENSATE FOR THESE VARIABLES

NOTE: SHOW LOCATION OF DRIER

1. FUNCTION

1. STOREHOUSE FOR LIQUID REFRIGERANT
2. REMOVES MOISTURE FROM REFRIGERANT

NOTE: MOISTURE IN THE SYSTEM COULD FREEZE AT THE EXPANSION VALVE

3. PROVIDES ADDITIONAL ONE TO ONE AND A HALF POUNDS OF REFRIGERANT TO THE SYSTEM
4. FILTERS FOREIGN PARTICLES FROM SYSTEM

2. CONSTRUCTION

1. HEAVY STEEL TUBING CAPPED ON EACH END

SHOW TRANSPARENCY: FIGURE 25

2. INLET AND OUTLET FITTING LOCATED ON CASE

NOTE: LOCATION IS DETERMINED BY THE RECEIVER MOUNTING POSITION

3. OUTLET TUBE (QUILL OR PICKUP TUBE) POSITIONED SO TUBE IS AS FAR BELOW THE LEVEL OF THE REFRIGERANT AS POSSIBLE
4. DRIER PORTION IS MADE UP OF TWO FILTER SCREENS AND FILTER DISCS

NOTE: SCREENS FILTER FOREIGN MATERIALS

5. DRIER, REFERRED TO AS A DESICCANT, IS USED TO ABSORB MOISTURE FROM REFRIGERANT

NOTE: THE DRIER, CALCIUM SULPHATE, IS ENCLOSED IN A FILTER OR MOLECULAR SIEVE

6. A FUSIBLE SAFETY PLUG IS INCORPORATED TO DISCHARGE THE SYSTEM WHEN TEMPERATURE GOES ABOVE SAFE LIMIT

NOTE: FUSIBLE PLUG WILL OPEN THE SYSTEM AT 232 DEGREES

3. RESULTS DUE TO RESTRICTION OF REFRIGERANT FLOW
   1. NORMAL OR LOW HEAD PRESSURE WITH LOW SUCTION PRESSURE
   2. EXCESSIVE COOLNESS OR FROSTING OF THE DEHYDRATOR, EXPANSION VALVE, AND COMPRESSOR SERVICE VALVE
   3. LITTLE OR NO COOLING FROM THE EVAPORATOR

B. THERMOSTAT AND MAGNETIC CLUTCH SYSTEM
   1. EARLY SYSTEM DID NOT PROVIDE MEANS FOR STOPPING PUMPING ACTION OF THE COMPRESSOR
   2. REMOVAL OF BELT WAS ONLY MEANS OF STOPPING COMPRESSOR
   3. SYSTEMS NOW USE THERMOSTAT - CONTROLLED SYSTEM WITH MAGNETIC CLUTCH

SHOW TRANSPARENCY: FIGURE 26

1. THERMOSTAT CONTROL
   1. CONTROL PARTS (SHOW ON TRANSPARENCY EACH PART AND EXPLAIN FUNCTION)
      a. CONTACT POINTS
      b. CAPILLARY BELLOWS ASSEMBLY
      c. CAPILLARY TUBE
      d. TEMPERATURE ADJUSTING SCREW
      e. THERMOSTATIC SWITCH
      f. RANGE SPRING
      g. CAM
      h. CLUTCH COIL
   2. CONTROL OPERATION
      a. OPENING AND CLOSING OF POINTS ARE CONTROLLED BY A TEMPERATURE SENSITIVE DIAPHRAGM OR BELLOWS
      b. CAPILLARY TUBE CONTAINING R-12 CONNECTED TO THE BELLOWS IS AFFECTED BY THE EVAPORATOR TEMPERATURE

      NOTE: CAPILLARY TUBE MAY HAVE COLD AIR FROM THE EVAPORATOR PASS OVER IT OR IT MAY BE CONNECTED TO THE TAIL PIPE OF THE EVAPORATOR
      c. EXPANSION OR CONTRACTION OF R-12 CAUSES THE BELLOWS TO EXPAND OR CONTRACT
      d. EXPANSION OR CONTRACTION OF

SHOW TRANSPARENCY: FIGURE 27

THE BELLOWS CAUSES CONTACT POINTS TO OPEN OR CLOSE

NOTE: POINTS CLOSING ENERGIZES COMPRESSOR CLUTCH, THEREBY BRINGING COMPRESSOR IN OPERATION

NOTE: POINTS OPENING BREAKS ELECTRICAL CIRCUIT TO CLUTCH, THEREBY STOPPING COMPRESSOR OPERATION

e. EVAPORATOR TEMPERATURE CONTROL SETTING IS DETERMINED BY TEMPERATURE CONTROL KNOB

NOTE: TEMPERATURE CAN BE SET BETWEEN 30 AND 60 DEGREES

2. MAGNETIC CLUTCH

1. USED TO CONNECT AND DISCONNECT COMPRESSOR FROM ENGINE
2. TYPES
   a. ROTATING COIL - THE MAGNETIC COIL IS INSIDE THE PULLEY AND ROTATES WITH IT
   b. STATIONARY COIL - THE MAGNETIC COIL IS MOUNTED ON THE FRAME OF THE COMPRESSOR AND DOES NOT ROTATE
   c. EITHER SIX OR TWELVE VOLT SYSTEMS

   NOTE: CAREFULLY NOTE THE VOLTAGE OF THE REPLACEMENT WHEN INSTALLING UNIT
3. CONSTRUCTION
   a. CLUTCH HUB
   b. CLUTCH COIL
   c. CLUTCH PULLEY
   d. BEARINGS
   e. ARMATURE
   f. ROTOR PLATE
4. OPERATION
   a. PULLEY ROTATES ON BALL BEARINGS MOUNTED ON CLUTCH HUB

   NOTE: PULLEY IS FREE TO ROTATE WITHOUT TURNING THE COMPRESSOR CRANKSHAFT UNTIL THE CLUTCH COIL IS ENERGIZED

   NOTE: THE FREE - ROTATING PULLEY AND NONENERGIZED CLUTCH COIL STOP COMPRESSOR OPERATION

SHOW TRANSPARENCIES: FIGURES 28 - 29

b. ARMATURE PLATE IS MOUNTED BY THE HUB TO THE COMPRESSOR CRANKSHAFT

c. ENERGIZING THE CLUTCH COIL CREATES A MAGNETIC FORCE THAT MOVES THE ARMATURE UNTIL IT CONTACTS THE ROTOR

NOTE: THE MAGNETIC FORCE LOCKS THE ROTOR AND ARMATURE PLATE TOGETHER

NOTE: THE CONNECTION PERMITS THE PULLEY TO ROTATE THE COMPRESSOR CRANKSHAFT AND OPERATE THE COMPRESSOR

d. SHUT-OFF OF THE ELECTRICAL CIRCUIT TO THE CLUTCH COIL DE-ENERGIZES THE MAGNETIC FORCE, THUS CAUSING THE ROTOR AND ARMATURE TO SEPARATE

NOTE: PULLEY WILL ROTATE FREELY ON THE COMPRESSOR CRANKSHAFT

e. COMPRESSOR WILL DISCONTINUE OPERATING

5. OPERATIONAL PRECAUTIONS

a. FULL VOLTAGE TO THE CLUTCH COIL MUST BE MAINTAINED

b. SPACING BETWEEN PULLEY AND COIL MUST BE CORRECT ON STATIONARY COIL MODELS

c. CORRECT SPACING BETWEEN ROTOR AND ARMATURE MUST BE MAINTAINED

d. MATING SURFACE MUST NOT BE WARPED

NOTE: WARPING IS CAUSED BY OVERHEATING

C. BYPASS SYSTEMS

THE BYPASS SYSTEM IS A METHOD OF CONTROLLING EVAPORATOR TEMPERATURE BY CONTROLLING ITS PRESSURE; THIS TYPE OF CONTROL DOES NOT USE A CYCLING CLUTCH AS A TEMPERATURE CONTROL METHOD, AND IS USED TO PREVENT THE EVAPORATOR FROM ICING UP

1. HOT GAS BYPASS VALVE
   1. USED TO PREVENT EVAPORATOR CORE FROM ICING
   2. POSITIONED ON THE OUTSIDE OF THE EVAPORATOR
   3. METERS A SMALL AMOUNT OF HOT GAS FROM THE COMPRESSOR INTO THE EVAPORATOR TO CONTROL PRESSURE

   SHOW TRANSPARENCY: FIGURE 30

   4. OPENING AND CLOSING OF VALVE IS CONTROLLED BY SELECTED EVAPORATOR PRESSURE
      NOTE: REMAINS CLOSED AS LONG AS PRESSURE REMAINS AT 29.5 P.S.I. OR HIGHER

2. SOLENOID BYPASS VALVE
   1. CONTAINS THERMAL SWITCH THAT IS ATTACHED TO THE SUCTION LINE OF THE EVAPORATOR

   SHOW TRANSPARENCY: FIGURE 31

   2. ELECTRICAL CONTACTS IN VALVE OPEN OR CLOSE WITH TEMPERATURE CHANGE
      NOTE: OPEN AT 25°F AND CLOSE AT 40°F
   3. OPENING OF THE VALVE PERMITS SMALL CHARGE OF HOT REFRIGERANT
   4. TEMPERATURE CONTROL CAN BE MAINTAINED WITHIN 15°

3. SUCTION THROTTLING REGULATORS

   MAINLY USED ON AUTOMOTIVE SYSTEMS

   a. OPERATION
      1. REGULATES THE FLOW OF REFRIGERANT FROM THE EVAPORATOR TO THE COMPRESSOR
      2. REGULATES EVAPORATOR PRESSURE BY REGULATING THE REFRIGERANT VAPOR ALLOWED TO LEAVE THE EVAPORATOR
      3. MAY BE MOUNTED IN THE TAIL PIPE OF THE EVAPORATOR SUCTION LINE, OR IN THE INLET OF THE COMPRESSOR
      4. COMPENSATES FOR VARYING CONDITIONS IN HEAT LOAD OR COMPRESSOR SPEED
         NOTE: AS TEMPERATURE AND PRESSURE WITHIN THE EVAPORATOR DROP, SPRING PRESSURE FORCES A VALVE WITHIN THE REGULATING DEVICE TOWARD ITS SEAT, RETARDING THE FLOW

OF REFRIGERANT; THIS ACTION INCREASES THE PRESSURE BACK INTO THE EVAPORATOR, RAISING BOTH PRESSURE AND TEMPERATURE

b. TYPES
SHOW TRANSPARENCY: FIGURE 32-33

1. MODULATOR VALVE
2. ROBOTROL VALVE
3. SELECTROL VALVE
4. EVAPORATOR PRESSURE REGULATOR VALVE
5. SUCTION THROTTLING VALVE

D. REFRIGERANT LINES AND CONNECTIONS

1. REFRIGERANT LINES CARRY REFRIGERANT BETWEEN THE MAJOR COMPONENTS OF THE SYSTEM
2. REFRIGERANT LINES ARE JOINED TO THE COMPONENTS BY CONNECTIONS

1. LINES

1. CONSTRUCTION
   a. REINFORCED SYNTHETIC RUBBER
   b. STEEL
   c. ALUMINUM
   d. COPPER
2. LOCATION
   a. SUCTION LINE (LOW PRESSURE LINE) - EVAPORATOR OUTLET TO COMPRESSOR INLET
   b. DISCHARGE LINE (PRESSURE LINE)- COMPRESSOR TO CONDENSER INLET
   c. LIQUID LINE (HIGH PRESSURE LIQUID LINE) - RECEIVER - DEHYDRATOR OUTLET TO THERMOSTATIC EXPANSION VALVE INLET
   d. HOT GAS BYPASS LINE (HOT GAS LINE) - COMPRESSOR OUTLET TO EVAPORATOR OUTLET
3. OPERATING TEMPERATURE OF LINES
   a. SUCTION LINE - COOL
   b. DISCHARGE LINE - HOT
   c. LIQUID LINE - WARM
   d. HOT GAS BYPASS LINE - WARM TO HOT (WHEN BYPASSING REFRIGERANT)
4. DIAGNOSIS OF LINES WHEN KINKED OR RESTRICTED
   a. SUCTION LINE - LOW SUCTION PRESSURE AT THE COMPRESSOR, LOW

DISCHARGE PRESSURE, LITTLE OR NO COOLING
- b. DISCHARGE LINE - COMPRESSOR RELIEF VALVE OPENS
- c. LIQUID LINE - LOW DISCHARGE PRESSURE, LOW SUCTION PRESSURE, NO COOLING
- d. HOT GAS BYPASS LINE - LOW SUCTION PRESSURE, POSSIBLE EVAPORATOR ICING

5. LINE SERVICE
   - a. FLUSH WITH HIGH-PRESSURE LIQUID REFRIGERANT
   - b. REPLACED IF LINE CANNOT BE SERVICED
   - c. PROPER OILING AND TIGHTENING OF CONNECTIONS
   - d. PROTECT HOSES FROM SHARP METAL EDGES, MOVING PARTS, OR HOT ENGINE PARTS

E. LINE CONNECTIONS SHOW TRANSPARENCY: FIGURE 34

1. JOINS COMPONENT PARTS TO REFRIGERANT LINES
2. TYPES
   - a. HOSE CLAMP FITTING
   - b. O - RING FITTING
   - c. FLARE FITTING
   - d. SELF SEALING COUPLING OR "QUICK DISCONNECTS"

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION,)

TRUE OR FALSE

1. THE DEMAND FOR REFRIGERANT BY THE EVAPORATOR WILL VARY WITH THE HEAT LOAD. T
2. MOISTURE COLLECTED INSIDE THE EXPANSION VALVE WILL CHANGE TO ICE. T
3. THE DRYING AGENT, DESICCANT, CAN HOLD AN UNLIMITED AMOUNT OF MOISTURE. F
4. RESTRICTION OF REFRIGERANT FLOW WILL CAUSE EXCESSIVE COOLNESS OR FROSTING OF THE DEHYDRATOR. T

5.	THE MODULATOR VALVE IS INSTALLED TO ALLOW SERVICING OF THE REFRIGERANT SYSTEM.	F
6.	REFRIGERANT LINES MUST BE ABLE TO WITHSTAND HIGH PRESSURE.	T
7.	THE OPERATION OF THE COMPRESSOR IS CONTROLLED BY THE THERMOSTAT AND MAGNETIC CLUTCH CONTROL.	T
8.	THE OPERATION OF THE THERMOSTAT IS CONTROLLED BY A TEMPERATURE-SENSITIVE DIAPHRAGM OR BELLOWS.	T
9.	TEMPERATURE CONTROL DEVICES, SUCH AS THE HOT GAS BYPASS, CONTROL THE CONDENSOR PRESSURE AND TEMPERATURE.	F
10.	THE RECEIVER-DRIER DECREASES THE CAPACITY OF THE SYSTEM'S AMOUNT OF USABLE REFRIGERANT.	F
11.	THE HOT GAS BYPASS VALVE WILL REMAIN CLOSED AS LONG AS THE EVAPORATOR PRESSURE IS 29.5 P.S.I. OR HIGHER.	T
12.	THE MOST COMMONLY USED TEMPERATURE CONTROL DEVICE ON THE AUTOMOTIVE SYSTEM IS THE SOLENOID BYPASS VALVE.	F
13.	THE EVAPORATOR PRESSURE REGULATOR VALVE IS ONE TYPE OF SUCTION THROTTLING REGULATORS.	T
14.	THE SUCTION LINE IS COMMONLY REFERRED TO AS THE PRESSURE LINE.	F
15.	UNDER NORMAL OPERATING CONDITIONS THE DISCHARGE LINE WILL BE HOT.	T

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

SIMPLE RECALL

1.	ON THE _____ CLUTCH, THE MAGNETIC COIL IS INSIDE THE PULLEY AND ROTATES WITH IT.	ROTATING COIL
2.	THE MAGNETIC FORCE ON A MAGNETIC CLUTCH LOCKS THE _____ AND ARMATURE PLATE TOGETHER.	ROTOR
3.	OVERHEATING OF THE ROTOR AND ARMATURE PLATE WILL RESULT IN SURFACE _____.	WARPAGE

4.	SMALL AMOUNTS OF HOT GAS ARE METERED FROM THE COMPRESSOR INTO THE EVAPORATOR THROUGH THE _____ BYPASS VALVE.	HOT GAS
5.	TEMPERATURE CONTROL OF THE EVAPORATOR CAN BE MAINTAINED WITHIN _____ DEGREES WITH THE SOLENOID BYPASS VALVE.	15
6.	THE _____ REGULATOR CONTROLS EVAPORATOR PRESSURE BY REGULATING THE AMOUNT OF REFRIGERANT ALLOWED TO LEAVE THE EVAPORATOR.	SUCTION THROTTLING
7.	THE EVAPORATOR OUTLET IS CONNECTED TO THE COMPRESSOR INLET BY THE _____.	SUCTION LINE
8.	THE LIQUID LINE (HIGH-PRESSURE LIQUID) CONNECTS THE _____ OUTLET TO THE THERMOSTATIC EXPANSION VALVE INLET.	RECEIVER-DRIER
9.	PLUGGED SERVICE LINES CAN USUALLY BE CLEARED BY FLUSHING WITH HIGH-PRESSURE LIQUID _____.	REFRIGERANT
10.	REFRIGERANT LINES ARE JOINED TO COMPONENT PARTS WITH _____.	LINE CONNECTIONS
11.	A SOLID SUBSTANCE CAPABLE OF REMOVING MOISTURE FROM A GAS, LIQUID, OR SOLID IS A _____.	DESICCANT
12.	RECEIVER-DRIERS ARE CONSTRUCTED WITH A _____ OR STRAINER TO CATCH ALL FOREIGN PARTICLES THAT MAY PASS INTO THE RECEIVER-DRIER.	FILTER
13.	A MAGNETIC CLUTCH THAT DOES NOT HAVE A ROTATING FIELD IS THE _____ FIELD CLUTCH.	STATIONARY
14.	THE THERMOSTATIC SWITCH IS CONTROLLED BY A TEMPERATURE SENSITIVE DIAPHRAGM OR _____.	BELLOWS

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

THE BASIC REFRIGERATION SYSTEM WILL OPERATE WELL UNDER CONSTANT

CONDITIONS, BUT THESE CONDITIONS CHANGE. THIS BEING THE CASE, ADDITIONAL COMPONENTS ARE REQUIRED TO CONTROL CONDITIONS IN ORDER TO MAINTAIN PROPER COOLING EFFICIENCY.

THE RECEIVER-DRIER, LOCATED BETWEEN THE CONDENSER AND THERMOSTATIC EXPANSION VALVE, STORES THE REFRIGERANT FOR THE SYSTEM. THE REFRIGERANT IS FILTERED FOR FOREIGN PARTICLES, AND THE MOISTURE IS REMOVED BY A DESSICANT OR DRYING AGENT.

THE EVAPORATOR TEMPERATURE CONTROL AND THE COMPRESSOR ON-OFF OPERATION IS CONTROLLED BY THE THERMOSTATIC SWITCH AND MAGNETIC CLUTCH. THE THERMOSTATIC SWITCH HAS ELECTRICAL CONTACTS THAT OPEN AND CLOSE. AS THE CONTACTS, WHICH OPERATE OFF OF A TEMPERATURE-SENSITIVE DIAPHRAGM OR BELLOWS ATTACHED TO OR LOCATED NEAR THE EVAPORATOR, CLOSE THE MAGNETIC CLUTCH IS ENERGIZED AND THE COMPRESSOR IS IN OPERATION. AS THE CONTACTS OPEN THE MAGNETIC CLUTCH IS DEENERGIZED CAUSING THE COMPRESSOR TO STOP. THERE ARE TWO TYPES OF MAGNETIC CLUTCHES, ONE WITH A ROTATING COIL AND THE OTHER HAS A STATIONARY COIL.

THROUGH THE USE OF A BYPASS CONTROL SYSTEM, THE EVAPORATOR TEMPERATURE AND PRESSURE CAN BE CONTROLLED. THREE TYPES OF BYPASS VALVES ARE: THE HOT GAS BYPASS VALVE; SOLENOID BYPASS VALVE; AND THE SUCTION THROTTLING VALVE, OF WHICH THERE ARE VARIOUS TYPES.

REFRIGERANT IS TRANSMITTED THROUGHOUT THE SYSTEM BY REFRIGERANT LINES. THESE LINES ARE MADE OF VARIOUS MATERIALS, SUCH AS REINFORCED RUBBER, STEEL, ALUMINUM OR COPPER, AND ARE CONNECTED TO THE COMPONENT PARTS WITH VARIOUS TYPES OF CONNECTORS.

SUGGESTED READING FOR THE STUDENT:

SERVICE MANUALS: CHRYSLER, FORD, AND GENERAL MOTORS
FUNDAMENTALS OF SERVICE - AIR CONDITIONING
AUTOMOTIVE AIR CONDITIONING

THE NEXT LESSON WILL BE: IX-A-6(I) "SERVICE EQUIPMENT"

INSTRUCTOR'S PLAN
MANIPULATIVE LESSON

IX-A-1(S)

TASK:	VISUAL INSPECTION
AIM:	THE STUDENT WILL BE ABLE TO MAKE VISUAL INSPECTION OF THE AUTOMOTIVE REFRIGERATION SYSTEM, AND TO DETERMINE THE REQUIRED ADJUSTMENTS OR CORRECTIVE MEASURES TO TAKE
TOOLS AND EQUIPMENT:	TUBING WRENCH SET, SOCKET AND WRENCH SET, BELT TENSION GAUGE OR RULE, SERVICE VALVE WRENCH, THERMOMETER, FENDER COVERS, AND SAFETY GOGGLES
MATERIALS:	CLEAN RAGS
TEACHING AIDS:	MANUFACTURER'S CHARTS AND SERVICE MANUALS
REFERENCES:	AUTOMOTIVE ENCYCLOPEDIA, PP. AUTO SERVICE AND REPAIR, PP. 32-7 TO 32-19 FUNDAMENTALS OF SERVICE AIR CONDITIONING, PP. 41-44 AUTOMOTIVE AIR CONDITIONING, PP. 166-170
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST HAVE STUDIED ALL PREVIOUS INFORMATION LESSONS AND ALL REQUIRED READING ASSIGNMENTS AND REALIZE SAFETY PRECAUTIONS TO OBSERVE AS A MEANS OF PREVENTING INJURY.
CHECKING STANDARDS:	1. PROPER SELECTION AND USE OF TOOLS 2. SHOW APPRECIATION FOR TOOLS, EQUIPMENT, PARTS, MATERIALS, AND CUSTOMER'S VEHICLE 3. PERFORMANCE OF TASK WITH SKILL 4. DEMONSTRATION OF SAFE WORKING HABITS AND ATTITUDE

I. PREPARATION (OF THE LEARNER - MOTIVATION)

SEASONAL CHECKS OF THE REFRIGERATION SYSTEM ARE VERY IMPORTANT IN REVEALING TROUBLES EARLY BEFORE THEY CAUSE FAILURE. A SMALL LEAK IN THE HOSES, A LOOSE COMPRESSOR BELT, OR A DIRTY OR CLOGGED CONDENSER WILL REDUCE THE PERFORMANCE OF THE REFRIGERATION SYSTEM AND EVENTUALLY LEAD TO MORE SERIOUS PROBLEMS. A COMPLETE VISUAL INSPECTION SHOULD BE MADE OF THE SYSTEM PRIOR TO MAKING A PERFORMANCE TEST OR DIAGNOSTIC TEST. A COMPLETE VISUAL INSPECTION MANY TIMES WILL REVEAL PROBLEMS OR ADDITIONAL WORK THAT MUST BE DONE BEFORE THE SYSTEM CAN BE BROUGHT TO FULL OPERATING EFFICIENCY. THE INSPECTION MAY ALSO SAVE CONSIDERABLE TIME AND SERVICE COST TO THE OWNER.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. DEMONSTRATE TASKS	1. PERFORM ALL TASKS 2. MAKE ALL KEY POINTS CLEAR AND PRECISE 3. EMPHASIZE SAFETY AND CAUTION AGAINST HAZARDOUS STEPS 4. ASK QUESTIONS OF THE STUDENTS
2. PREPARE VEHICLE	1. POSITION VEHICLE IN WORK STALL 2. SET PARKING BRAKES 3. COVER FENDER WITH FENDER COVERS 4. DISCONNECT GROUND BATTERY CABLE
3. INSPECT COMPRESSOR BELT	1. BELT TENSION TOO TIGHT NOTE: TOO TIGHT TENSION WILL RESULT IN STRAIN AND DAMAGE TO COMPRESSOR PULLEY BEARINGS 2. BELT TENSION TOO LOOSE NOTE: TOO LOOSE BELT WILL CAUSE BELT SLIPPAGE AND POOR PERFORMANCE 3. TIGHTEN BELT TENSION USING TENSION GAUGE OR BY MEASURING DEFLECTION BETWEEN THE TWO PULLEYS FARTHEST APART NOTE: DEFLECTION SHOULD BE BETWEEN 3/8 INCH AND 1/2 INCH 3. INSPECT PULLEYS FOR PROPER ALIGNMENT NOTE: IMPROPER ALIGNMENT WILL CAUSE UNDUE SIDE WEAR TO BELT AND PULLEY 4. CHECK BELTS FOR GLAZED, CRACKED, FRAYED, OR WORN NOTE: REPLACE BELTS FOR ANY OF THESE CONDITIONS NOTE: CONDITION MAY BE CAUSED BY OLD BELTS, IMPROPER TENSION, IMPROPER ALIGNMENT, OR INCORRECT BELT
4. INSPECT COMPRESSOR BRACKETS	1. BRACKETS AND BRACES CONDITION

	NOTE: CHECK FOR CRACKS OR BROKEN PARTS
	2. LOOSE MOUNTING BOLTS NOTE: LOOSE BOLTS WILL PERMIT VIBRATION AND STRAIN ON BRACKETS DURING OPERATION
	3. REPAIR OR REPLACE BRACKETS OR BRACES DAMAGED
	4. PROPERLY TIGHTEN MOUNTING BOLTS THAT ARE LOOSE NOTE: REPLACE DAMAGED OR MISSING BOLTS
5. INSPECT HOSES, LINES, AND FITTING	1. LOOSE CONNECTIONS
	2. LOOSE HOSE CLAMPS
	3. LEAKING LINES
	4. DETERIORATED GROMMETS AND RUBBER PADS NOTE: TO PREVENT RUBBING OR CHAFING OF HOSE OR LINE INSTALL SOME TYPE OF PROTECTIVE MATERIAL
6. INSPECT COMPRESSOR CLUTCH	1. CLUTCH ENGAGES PROPERLY
	2. CLUTCH TURNS FREELY WHEN DISENGAGED
	3. CHECK FOR CLUTCH SLIPPAGE
	4. SOUNDS THAT INDICATE WORN BEARINGS
7. INSPECT CONDENSER	1. CONDENSER PROPERLY MOUNTED
	2. FREE OF CLOGGING FINS BY DIRT OR INSECTS NOTE: BLOCKING OF FULL AIR FLOW OVER THE CONDENSER COILS MUST BE CLEARED TO ALLOW PROPER CONDENSING ACTION NOTE: INDICATES PARTIAL RESTRICTION
8. BLOWER MOTOR	1. CHECK FOR NOISE THAT WOULD INDICATE WORN BEARINGS
	2. OPERATE BLOWER MOTOR AT ALL SPEEDS TO INSURE PROPER OPERATION
	3. BE SURE AIR IS DIRECTED TO SELECTED AREA
	4. MAKE SURE EVAPORATOR DRAIN IS OPEN
9. SIGHT GLASS	1. LET RUN FOR FIVE MINUTES

	2. CHECK FOR FOAM OR BUBBLES NOTE: LACK OF FOAM OR BUBBLES INDICATES A FULL CHARGE NOTE: IF TEMPERATURE IS BELOW 70°F SLIGHT FOAMING IS NORMAL
	3. CHECK FOR OIL FILM FLOW ACROSS SIGHT GLASS NOTE: THIS INDICATES COMPLETELY EMPTY SYSTEM
10. ELECTRICAL CONNECTIONS	1. BLOWN FUSE
	2. DISCONNECTED OR BROKEN WIRE
	3. DISCONNECTED OR BROKEN GROUND WIRE
11. EVAPORATOR	1. INSPECT AND CLEAN DRAIN SYSTEM
	2. FREE FROM DUST, LINT, OR RESTRICTION OF EVAPORATOR PASSAGES NOTE: THIS CHECK MAY NOT BE ACCESSIBLE DUE TO LOCATION OF EVAPORATOR
12. AIR DUCTS AND LOUVERS	1. INSPECT FOR FREE OPERATION NOTE: SHOULD OPERATE WITHOUT STICKING OR BINDING
	2. CHECK FOR DUST OR LINT CLOGGING

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PERFORM TASKS UNDER CLOSE SUPERVISION USING TASK SHEETS.
2. CHECK STUDENTS FOR KEY POINTS.
3. FURNISH STUDENTS WITH JOB AND TASK SHEETS.

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

1. HAVE STUDENTS PERFORM THE TASKS ON THEIR OWN.
2. EVALUATE THE STUDENTS' PERFORMANCE.
3. RECORD RESULTS ON PROGRESS CHART.
4. RETEACH IF NEED IS EVIDENT.
5. HAVE RE-PERFORM THE TASK IF PERFORMANCE IS UNACCEPTABLE.

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. STRESS KEY POINTS.
2. EMPHASIZE STEPS.
3. POINT OUT IMPORTANCE FOR AN ACCURATE INSPECTION.
4. EMPHASIZE SAFETY.
5. EMPHASIZE IMPORTANCE OF TECHNIQUE APPLICATION.

SUGGESTED READING FOR STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, PP.
AUTO SERVICE AND REPAIR, PP. 32-7 TO 32-19
FUNDAMENTALS OF SERVICE AIR CONDITIONING, PP. 41-44
AUTOMOTIVE AIR CONDITIONING, PP. 166-170

THE NEXT LESSON IS: IX-A-2(S) "DIAGNOSE AIR CONDITIONING CONTROLS"

JOB SHEET IX-A-1(J)
IN
AUTOMOTIVE AIR CONDITIONING

JOB:	VISUAL INSPECTION
MATERIALS:	CLEAN RAGS
TOOLS AND EQUIPMENT:	TUBING WRENCH SET, SOCKET AND WRENCH SET, BELT TENSION GAUGE, RULE, SERVICE VALVE WRENCH, THERMOMETER, FENDER COVERS, SAFETY GOGGLES, AND CLEAN RAGS
GENERAL INSTRUCTIONS:	THE VISUAL INSPECTION OF THE REFRIGERANT SYSTEM IS VERY IMPORTANT TO THE TOTAL DIAGNOSIS AND SERVICE OF THE SYSTEM. BEFORE BEGINNING THIS JOB THE STUDENT SHOULD HAVE COVERED LESSONS IX-A-5 AND IX-A-6, AND HAVE REVIEWED ALL SAFETY PRECAUTIONS.

PROCEDURES AND/OR TASKS:	IX-A-1(TS)	INSPECT COMPRESSOR BELTS
	IX-A-1a(TS)	INSPECT COMPRESSOR BRACKETS
	IX-A-1b(TS)	INSPECT HOSES, LINES, AND FITTINGS
	IX-A-1c(TS)	INSPECT COMPRESSOR CLUTCH
	IX-A-1d(TS)	INSPECT CONDENSER
	IX-A-1e(TS)	CHECK BLOWER MOTOR
	IX-A-1f(TS)	INSPECT SIGHT GLASS

CHECK POINT: HAVE INSTRUCTOR CHECK EACH PROCEDURE DURING PERFORMANCE OF TASK

TASK SHEET IX-A-1(TS)

TASK: INSPECT COMPRESSOR BELTS

JOB: VISUAL INSPECTION

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: APPROPRIATE WRENCHES, BELT TENSION GAUGE, RULE, FENDER COVERS, SAFETY GOGGLES, AND CLEAN RAGS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INSPECT CONDITION OF BELTS	1. GLAZED CONDITION DUE TO LOOSE BELT 2. CRACKED OR FRAYED CONDITION CAUSED BY WEATHERED OR AGED CONDITION 3. INCORRECT BELT SIZE NOTE: REPLACE BLET IF ANY OF THESE CONDITIONS EXIST
2. MEASURE BELT TENSION	1. INSPECT FOR TOO TIGHT NOTE: EXCESS TIGHTNESS WILL RESULT IN STRAIN AND DAMAGE TO COMPRESSOR PULLEY BEARINGS 2. INSPECT FOR TOO LOOSE BELT NOTE: A LOOSE BELT WILL PERMIT SLIPPAGE UNDER LOAD, CAUSING WEAR ON BELT AND POOR COMPRESSOR PERFORMANCE 3. ADJUST BELT TO PROPER TENSION NOTE: USE EITHER BELT TENSION GAUGE OR MEASURE DEFLECTION BETWEEN THE TWO PULLEYS FARTHEST APART NOTE: DEFLECTION MEASURED WITH A RULE SHOULD BE BETWEEN 3/8" AND 1/2" 4. TIGHTEN BOLTS PROPERLY
3. SECURE WORK STATION	1. DISCARD REPLACED BELTS 2. WIPE ALL TOOLS CLEAN AND STORE PROPERLY 3. PROCEED TO NEXT TASK

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TASK SHEET IX-A-1a(TS)

TASK: INSPECT COMPRESSOR BRACKETS

JOB: VISUAL INSPECTION

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: APPROPRIATE WRENCHES, FENDER COVERS, CLEAN RAGS, AND SAFETY GOGGLES

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INSPECT MOUNTING BOLTS	1. CHECK MOUNTING BOLTS FOR DAMAGED OR STRIPPED THREADS 2. CHECK TIGHTNESS OF BOLTS NOTE: LOOSE BOLTS WILL CAUSE VIBRATION IN COMPRESSOR AND BRACKETS, THEREBY EVENTUALLY CAUSING BREAKAGE 3. REPLACE ANY BOLTS THAT ARE WORN OR DAMAGED 4. TIGHTEN BOLTS TO CORRECT TIGHTNESS
2. INSPECT MOUNTING BRACKETS	1. CHECK BRACKETS AND BRACES FOR CRACKED OR BROKEN PARTS 2. REMOVE DAMAGED PARTS 3. REPLACE OR REPAIR DAMAGED PART 4. INSTALL PART 5. TIGHTEN MOUNTING BOLTS TO PROPER TIGHTNESS
3. SECURE WORK STATION	REFER TO IX-A-(TS)

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TASK: INSPECT HOSES, LINES, AND FITTINGS

JOB: VISUAL INSPECTION

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: FLARE NUT (TUBING) WRENCHES, TORQUE WRENCH, SCREWDRIVER, CLEAN RAGS, AND SAFETY GOGGLES

TASK BREAKDOWN:

STEPS	KEY POINTS
1. CHECK HOSES FOR WEAR OR DAMAGE	1. INSPECT FOR DETERIORATED GROMMETS AND RUBBER PADS NOTE: PROTECT AGAINST HOSES RUBBING AGAINST METAL PARTS, THEREBY CAUSING DETERIORATION AND LEAKS IN HOSE 2. REPLACE GROMMETS OR RUBBER PADS NOTE: SHOULD NEW GROMMETS OR PADS NOT BE AVAILABLE INSTALL OTHER TYPE OF PROTECTIVE MATERIAL 3. INSPECT COPPER TUBING FOR KINKS OR SHARP BENDS NOTE: SHARP BENDS OR KINKS RESTRICT REFRIGERANT FLOW AND THEREFORE WILL REQUIRE REPAIR OR REPLACEMENT
2. INSPECT TUBING CONNECTIONS	1. CHECK ALL TUBING FITTINGS FOR LOOSE CONNECTION NOTE: USE TORQUE WRENCH TO CHECK 2. TIGHTEN FITTINGS TO SPECIFICATIONS NOTE: USE FLARE NUT WRENCH AND TORQUE WRENCH TO AVOID DAMAGE TO TUBING OR FLARE NUT
3. INSPECT HOSE CLAMPS	1. CHECK FOR PROPER INSTALLATION ON HOSE NOTE: HOSE CLAMP POSITIONED SO THAT LOCATING FINGERS OF CLAMP ARE TOUCHING LOCATING BEAD 2. INSPECT CONDITION OF HOSE AROUND CLAMP NOTE: TIGHTENING CLAMP TOO TIGHT

STEPS	KEY POINTS
	WILL CAUSE CUTTING OF HOSE
	3. INSPECT CONDITION OF CLAMP
4. SECURE WORK STATION	REFER TO IX-A-1(TS)

TASK SHEET IX-A-1c(TS)

TASK: INSPECT COMPRESSOR CLUTCH

JOB: VISUAL INSPECTION

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, FENDER COVERS, AND SAFETY GOGGLES

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. PLACE VEHICLE IN WORK STALL 2. SET EMERGENCY BRAKE 3. PLACE FENDER COVERS ON FENDERS
2. INSPECT CLUTCH FOR FREE MOVEMENT	1. START ENGINE NOTE: SET ENGINE RPM AT 1200 2. INSPECT CLUTCH FOR FREE TURNING NOTE: IF THERE IS REASON TO BELIEVE CLUTCH IS NOT TURNING FREELY, SHUTDOWN ENGINE, EITHER LOOSEN COMPRESSOR BELT OR REMOVE BELT, AND TURN CLUTCH BY HAND 3. LISTEN FOR SOUND INDICATING WORN BEARINGS NOTE: IF CLUTCH DOES NOT TURN FREELY OR THERE IS AN INDICATION OF WORN BEARINGS THE COMPRESSOR WILL REQUIRE REMOVAL AND AN OVERHAUL
3. INSPECT CLUTCH FOR OPERATING CONDITION	1. WITH ENGINE RUNNING, TURN ON THE AIR CONDITIONING SWITCH 2. INSPECT CLUTCH FOR PROPER ENGAGING 3. INSPECT CLUTCH TO SEE IF CLUTCH IS SLIPPING 4. LISTEN FOR INDICATIONS OF WORN BEARINGS NOTE: IF CLUTCH FAILS TO ENGAGE OR IS SLIPPING, FURTHER DIAGNOSIS WILL BE REQUIRED 5. SHUT OFF ENGINE
4. SECURE WORK STATION	REFER TO IX-A-1(TS)

TASK: INSPECT CONDENSER

JOB: VISUAL INSPECTION

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, SOFT BRUSH (BENCH BRUSH), WATER HOSE, REQUIRED WRENCHES, AND SAFETY GOGGLES

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	REFER TO IX-A-1(TS)
2. INSPECT EXTERIOR CONDITION	1. INSPECT MOUNTING OF CONDENSER 2. CHECK MOUNTING BOLTS OF THE CONDENSER AND PROPERLY TIGHTENED 3. INSPECT FINS FOR CLOGGING BY DIRT OR INSECTS 4. CLEAN CONDENSER FINS WITH SOFT BRUSH 5. FLUSH WITH WATER HOSE FROM INSIDE CAUTION: DO NOT USE COMPRESSED AIR
3. INSPECT WITH SYSTEM IN OPERATION	1. START ENGINE 2. TURN ON AIR CONDITIONING SWITCH 3. INSPECT CONDENSER FOR ICY OR FROSTY SPOTS ON THE EXTERIOR OF CONDENSER NOTE: ICY OR FROSTY APPEARANCE INDICATES PARTIAL RESTRICTION OF CONDENSING UNIT NOTE: IF THIS CONDITION EXISTS, FURTHER DIAGNOSTIC CHECKS WILL BE REQUIRED 4. TURN OFF AIR CONDITIONING SWITCH AND ENGINE
4. SECURE WORK STATION	REFER TO IX-A-1(TS)

TASK: CHECK BLOWER MOTOR

JOB: VISUAL INSPECTION

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, AND ROD OR WIRE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	REFER TO IX-A-1(TS)
2. CHECK OPERATION	1. TURN ON BLOWER SWITCH 2. OPERATE BLOWER AT ALL SPEEDS 3. CHECK FOR PROPER OPERATION AT ALL SPEEDS 4. LISTEN FOR NOISE THAT MAY INDICATE WORN BEARINGS NOTE: IF BLOWER IS NOISY OR FAILS TO OPERATE PROPERLY AT ALL SPEEDS, IT WILL BE NECESSARY TO REPAIR IT 5. CHECK CORRECT DIRECTION OF AIR FLOW
3. CHECK EVAPORATOR DRAIN	1. INSPECT DRAIN FOR CLOGGED CONDITION 2. CLEAR LINE IF RESTRICTED BY RUNNING A ROD UP INTO DRAIN LINE
4. SECURE WORK STATION	REFER TO IX-A-1(TS)

TASK: INSPECT SIGHT GLASS

JOB: VISUAL INSPECTION

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, SAFETY GOGGLES AND CLEAN RAGS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	REFER TO IX-A-1(TS)
2. PREPARE FOR OPERATIONAL TEST	1. START ENGINE 2. TURN ON AIR CONDITIONER SWITCH NOTE: LET RUN FOR ABOUT FIVE MINUTES 3. SET CONTROLS FOR MAXIMUM COOLING
3. CHECK SIGHT GLASS FOR FULL CHARGE	1. WIPE SIGHT GLASS CLEAN 2. INSPECT FOR FOAM OR BUBBLES NOTE: LACK OF FOAM OR BUBBLES INDICATES A FULL REFRIGERANT CHARGE NOTE: TEMPERATURE BELOW 70°F WILL CAUSE A NORMAL SLIGHT FOAMING EFFECT 3. CHECK FOR OIL FILM FLOW ACROSS SIGHT GLASS NOTE: OIL FILM INDICATES COMPLETELY EMPTY SYSTEM NOTE: SYSTEM WILL REQUIRE CHARGING BEFORE OTHER PERFORMANCE TEST CAN BE MADE 4. TURN OFF AIR CONDITIONER AND ENGINE
4. SECURE WORK STATION	REFER TO IX-A-1(TS)

INSTRUCTOR'S PLAN IX-A-2(S)

MANIPULATIVE LESSON

TASK:	DIAGNOSE AIR CONDITIONING CONTROLS
AIM:	STUDENT WILL BE ABLE TO DIAGNOSE BASIC PROBLEMS RELATED TO AIR CONDITIONING CONTROLS
TOOLS AND EQUIPMENT:	12 VOLT TEST LIGHT, VACUUM GAGE, VACUUM HAND PUMP, AND JUMPER WIRE
MATERIALS:	RAGS
TEACHING AIDS:	AIR CONDITIONING CONTROL CIRCUIT
REFERENCES:	AUTOMOTIVE SERVICE MANUALS AUTO SERVICE AND REPAIR, STOCKEL, CH. 32 AUTOMOTIVE MECHANICS, CROUSE, CH. 43 AUTOMOTIVE ENCYCLOPEDIA, GOODHEART-WILLCOX, PP. 635-646
PREREQUISITE EXPERIENCE OF THE THE LEARNER:	THE STUDENT MUST KNOW THE MATERIAL COVERED IN PREVIOUS TASKS PERTAINING TO AIR CONDITIONING AND BE FAMILIAR WITH AIR CONDITIONING NOMENCLATURE
CHECKING STANDARDS:	1. PROPER SELECTION OF TOOLS AND EQUIPMENT 2. FOLLOW STEP BY STEP PROCEDURE OF DIAGNOSIS 3. KNOW PROPER NOMENCLATURE OF PARTS 4. WORK IN A PROFESSIONAL MANNER

I. PREPARATION (OF THE LEARNER - MOTIVATION)

EVERY JOB ATTEMPTED IN THE AUTOMOTIVE SHOP MUST BE DONE IN A SYSTEMATIC MANNER. IN THIS LESSON WE WILL COVER THE BASIC CONTROLS OF THE AIR CONDITIONING SYSTEM AND DIAGNOSE PROBLEMS THROUGH A STEP BY STEP PROCEDURE.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. DEMONSTRATION	1. PERFORM ALL TASKS 2. MAKE ALL POINTS CLEAR AND PRECISE 3. EMPHASIZE SAFETY AND KEY POINTS
2. PREPARE VEHICLE	1. PLACE VEHICLE IN WORK STALL 2. SET EMERGENCY BRAKE 3. USE FENDER COVERS

CAUTION: ELECTRICAL SYSTEM MUST BE ENERGIZED TO PERFORM THE FOLLOWING DIAGNOSIS

3. TEST BLOWER MOTOR ELECTRICAL CIRCUIT

NOTE: USE 12 VOLT TEST LIGHT TO CHECK CURRENT AT THE FOLLOWING COMPONENTS

1. CHECK CURRENT AT STORAGE BATTERY
2. WITH IGNITION SWITCH OFF, CURRENT SHOULD BE COMING INTO SWITCH
3. TURN SWITCH ON, CURRENT SHOULD BE LEAVING IGNITION SWITCH ALSO
4. CHECK CURRENT AT FUSE BOX
   NOTE: BOTH ENDS OF AIR CONDITIONING FUSE SHOULD BE ENERGIZED
5. WITH BLOWER SWITCH IN OFF POSITION, ONE WIRE SHOULD BE ENERGIZED AT BLOWER MOTOR SWITCH
6. TURN BLOWER SWITCH ON, WIRE GOING TO BLOWER MOTOR SHOULD BE ENERGIZED
7. CHECK BLOWER MOTOR RELAY, IF SO EQUIPPED
8. CHECK WIRE CONNECTION AT BLOWER MOTOR
9. CHECK GROUND WIRE AT BLOWER MOTOR

   NOTE: IF WIRE CONNECTED TO BLOWER MOTOR IS ENERGIZED AND GROUND WIRE IS PROPERLY CONNECTED BUT BLOWER MOTOR DOES NOT FUNCTION, REPLACE BLOWER MOTOR

   NOTE: SOME AIR CONDITIONING SYSTEMS HAVE ADDITIONAL COMPONENTS IF SO, SPECIFIC SERVICE MANUALS SHOULD BE USED

4. TEST AIR CONDITIONING COMPRESSOR ELECTRICAL CIRCUIT

NOTE: USE 12 VOLT TEST LIGHT TO CHECK CURRENT AT THE FOLLOWING COMPONENTS

1. CHECK CURRENT AT STORAGE BATTERY
2. WITH IGNITION SWITCH OFF, CURRENT SHOULD BE COMING INTO SWITCH
3. TURN SWITCH ON, CURRENT SHOULD BE LEAVING IGNITION SWITCH ALSO
4. CHECK CURRENT AT FUSE BOX

NOTE: BOTH ENDS OF AIR CONDITIONING FUSE SHOULD BE ENERGIZED

5. WITH BLOWER SWITCH IN OFF POSITION, ONE WIRE SHOULD BE ENERGIZED AT BLOWER MOTOR SWITCH
6. TURN BLOWER SWITCH ON, WIRE GOING TO COMPRESSOR SHOULD BE ENERGIZED
7. CHECK CURRENT TO THERMOSTAT CONTROL OR SELECTOR LEVER, AS APPLICABLE
8. TURN THERMOSTAT CONTROL TO "COLD" POSITION OR SELECTOR LEVER TO "AIR CONDITION" POSITION, AS APPLICABLE, CURRENT SHOULD BE LEAVING THE SWITCH
9. CHECK CURRENT AT COMPRESSOR SAFETY SWITCH, IF APPLICABLE
10. CHECK CURRENT AT COMPRESSOR
11. CHECK GROUND WIRE AT COMPRESSOR

NOTE: IF WIRE CONNECTION AT COMPRESSOR IS ENERGIZED AND GROUND WIRE IS PROPERLY CONNECTED, COMPRESSOR CLUTCH SHOULD "KICK IN"

NOTE: SOME AIR CONDITIONING SYSTEMS HAVE ADDITIONAL COMPONENTS; IF SO, SPECIFIC SERVICE MANUALS SHOULD BE USED

5. CHECK AIR DIVERTER DOORS
(MANUAL OPERATION)
A. TEMPERATURE DIVERTER DOOR

NOTE: THIS PROCEDURE WILL COVER THE MANUAL TYPE METHOD OF CONTROLLING TEMPERATURE THROUGH THE USE OF CONTROL CABLES

1. DISCONNECT NEGATIVE BATTERY CABLE
2. CHECK CONTROL CABLE ATTACHMENT AT AIR CONDITIONING CONTROL PANEL (TEMPERATURE LEVEL)

CAUTION: RETAINER CLIPS SOMETIMES WORK LOOSE

3. CHECK ROUTING OF CABLE ASSEMBLY FOR KINKS OR BINDING OF CONTROL CABLE
4. CHECK FOR PROPER ATTACHMENT OF CABLE AT AIR DIVERTER DOOR
5. MOVE TEMPERATURE SELECTOR LEVER ON AIR CONDITIONING CONTROL PANEL,

AIR DIVERTER DOOR SHOULD MOVE ACCORDINGLY

NOTE: MOVEMENT OF THE TEMPERATURE AIR DIVERTER DOOR REGULATES THE AMOUNT OF AIR CONDITIONED AIR THAT IS ALLOWED TO ENTER THE PASSENGER COMPARTMENT

B. POSITION SELECTOR DIVERTER DOOR

NOTE: THIS PROCEDURE WILL COVER THE MANUAL TYPE WAY OF CONTROLLING THE DIRECTION OF AIR FLOW

1. POSITION SELECTOR LEVER WILL USUALLY HAVE 3 POSITIONS-DEFROST, AIR CONDITION, AND HEATER
2. CHECK CONTROL CABLE ATTACHMENT AT CONTROL PANEL
   CAUTION: RETAINER CLIPS SOMETIMES WORK LOOSE
3. CHECK ROUTING OF CABLE ASSEMBLY FOR KINKS OR BINDING OF CONTROL CABLE
4. CHECK FOR PROPER ATTACHMENT OF CABLE AT DIVERTER DOOR
5. MOVE POSITION SELECTOR LEVER ON CONTROL PANEL
   NOTE: AIR DIVERTER DOOR SHOULD MOVE ACCORDINGLY
6. CHECK AIR DUCTS FOR FOREIGN MATERIAL LODGED AGAINST AIR DIVERTER DOOR, PREVENTING PROPER OPERATION
   NOTE: SOME AIR CONDITIONING SYSTEMS HAVE ADDITIONAL COMPONENTS AND CONTROLS; IF SO, SPECIFIC SERVICE MANUALS SHOULD BE USED
7. RECONNECT NEGATIVE BATTERY CABLE

6. CHECK AIR DIVERTER DOORS (VACUUM OPERATED)

NOTE: THIS PROCEDURE COVERS THE VACUUM (PNEUMATIC) OPERATED WAY OF CONTROLLING AIR DIVERTER DOORS. NO CONTROL CABLES ARE USED

1. ENGINE MUST BE RUNNING TO PROVIDE A VACUUM SOURCE
2. CHECK VACUUM HOSE CONNECTION AT VACUUM SOURCE (ENGINE)
3. CHECK VACUUM RESERVE TANK FOR

PROPER CONNECTIONS AND VACUUM LEAK

4. CHECK AIR CONDITIONING CONTROL ASSEMBLY FOR PROPER CONNECTION OF VACUUM HOSE AND VACUUM LEAKS
5. CHECK HOSE ROUTING AND HOSES FOR LEAKS
   NOTE: AS CONTROL LEVERS ARE ACTUATED, VACUUM IS DIRECTED TO ACTUATOR AIR VALVES
6. CHECK FOR PROPER HOSE ROUTING TO ACTUATOR AIR VALVES AND HOSES FOR LEAKS
7. CHECK ACTUATOR AIR VALVES FOR VACUUM LEAKS (USE VACUUM HAND PUMP)
8. CHECK FOR PROPER ATTACHMENT OF ACTUATOR LEVERS FROM ACTUATOR AIR VALVES TO AIR DIVERTER DOORS
9. MOVE CONTROL LEVER TO SELECTED POSITIONS, AIR DIVERTER DOORS SHOULD MOVE ACCORDINGLY
   NOTE: EACH AIR CONDITIONING CONTROL SYSTEM WILL VARY AS TO THE LOCATION AND OPERATION OF AIR DIVERTER DOORS. SERVICE MANUALS PERTAINING TO SPECIFIC MODELS SHOULD BE USED WHENEVER POSSIBLE

7. CLEAN WORK STATION — AS IN PREVIOUS LESSON

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. CHECK STUDENTS FOR KEY POINTS
2. STUDENTS TO REPEAT STEPS AND KEY POINTS AS THEY PERFORM TASKS
3. STUDENTS WORK TO PASS CHECKING STANDARDS

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

PUT STUDENTS ON THEIR OWN FOR PERFORMANCE TESTS

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT STEPS AND KEY POINTS IN A BRIEF REVIEW
2. EMPHASIZE CAUTIONS AND NOTES
3. EMPHASIZE THAT CHECKING PROCEDURE SHOULD BE PERFORMED IN A SYSTEMATIC PROCEDURE

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE SERVICE MANUALS
AUTO SERVICE AND REPAIR. STOCKEL, CH. 32
AUTOMOTIVE MECHANICS, CROUSE, CH. 43
AUTOMOTIVE ENCYCLOPEDIA, GOODHEART-WILLCOX, PP. 635-646

THE NEXT LESSON IS: IX-B-1(S) "SERVICING AIR CONDITIONING SYSTEM"

JOB SHEET IX-A-2(J)

JOB:	DIAGNOSIS OF AIR CONDITIONING CONTROLS	
MATERIALS:	RAGS	
TOOLS AND EQUIPMENT:	12 VOLT TEST LIGHT, VACUUM GAGE, VACUUM HAND PUMP, JUMPER WIRE, AND FENDER COVERS	
GENERAL INSTRUCTIONS:	THIS JOB COVERS JUST THE BASIC FUNCTIONS AND PROCEDURES IN DIAGNOSING CONTROL PROBLEMS. WHENEVER POSSIBLE, USE SPECIFIC SERVICE MANUALS.	
PROCEDURES AND/OR TASKS:	IX-A-2(TS)	TEST BLOWER MOTOR ELECTRICAL CIRCUIT
	IX-A-2a(TS)	TEST AIR CONDITIONING COMPRESSOR ELECTRICAL CIRCUIT
	IX-A-2b(TS)	CHECK AIR DIVERTER DOORS (MANUAL OPERATED)
	IX-A-2c(TS)	CHECK AIR DIVERTER DOORS (VACUUM OPERATED)
CHECK POINTS:	BEFORE PROCEEDING FURTHER, HAVE INSTRUCTOR CHECK WORK.	
	IX-A-1(TS)	CLEAN WORK STATION

TASK: TEST BLOWER MOTOR ELECTRICAL CIRCUIT

JOB: DIAGNOSE AIR CONDITIONING CONTROLS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: 12 VOLT TEST LIGHT, FENDER COVERS, JUMPER WIRE, AND RAGS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. PLACE VEHICLE IN WORK STALL 2. SET EMERGENCY BRAKE 3. USE FENDER COVERS CAUTION: ELECTRICAL SYSTEM MUST BE ENERGIZED TO PERFORM THE FOLLOWING DIAGNOSIS NOTE: USE 12 VOLT TEST LIGHT TO CHECK CURRENT AT THE FOLLOWING COMPONENTS
2. CHECK STORAGE BATTERY	1. WITH IGNITION SWITCH OFF, CURRENT SHOULD BE COMING INTO SWITCH 2. TURN SWITCH ON, CURRENT SHOULD BE LEAVING IGNITION SWITCH ALSO
3. CHECK FUSE BOX	NOTE: BOTH ENDS OF AIR CONDITIONING FUSE SHOULD SHOW CONTINUITY 1. WITH BLOWER MOTOR SWITCH AT OFF POSITION, ONE WIRE SHOULD BE ENERGIZED AT THE BLOWER MOTOR SWITCH 2. TURN BLOWER MOTOR SWITCH ON, WIRE GOING TO BLOWER MOTOR SHOULD BE ENERGIZED
4. CHECK BLOWER MOTOR RELAY	1. CHECK WIRE CONNECTION AT BLOWER MOTOR 2. CHECK GROUND WIRE CONNECTION AT BLOWER MOTOR NOTE: IF WIRE CONNECTED TO BLOWER MOTOR IS ENERGIZED AND GROUND WIRE IS PROPERLY CONNECTED BUT BLOWER MOTOR DOES NOT FUNCTION, REPLACE BLOWER MOTOR NOTE: SOME AIR CONDITIONING SYSTEMS HAVE ADDITIONAL COMPONENTS; IF SO, SPECIFIC SERVICE MANUALS

STEPS	KEY POINTS
	SHOULD BE USED
5. CLEAN WORK STATION	REFER TO IX-A-1(TS)

TASK: TEST AIR CONDITIONING COMPRESSOR ELECTRICAL CIRCUIT

JOB: DIAGNOSE AIR CONDITIONING CONTROLS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: 12 VOLT TEST LIGHT, FENDER COVERS, JUMPER WIRE, AND RAGS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. PLACE VEHICLE IN WORK STALL 2. SET EMERGENCY BRAKE 3. USE FENDER COVERS CAUTION: ELECTRICAL SYSTEM MUST BE ENERGIZED TO PERFORM THE FOLLOWING DIAGNOSIS
2. CHECK STORAGE BATTERY	NOTE: USE 12 VOLT TEST LIGHT TO CHECK THE FOLLOWING COMPONENTS 1. WITH IGNITION SWITCH OFF, CURRENT SHOULD BE COMING INTO SWITCH 2. TURN SWITCH ON, CURRENT SHOULD BE LEAVING IGNITION SWITCH ALSO
3. CHECK CURRENT AT FUSE BOX	NOTE: BOTH ENDS OF AIR CONDITIONING FUSE SHOULD SHOW CONTINUITY 1. WITH BLOWER SWITCH IN OFF POSITION, ONE WIRE SHOULD BE ENERGIZED AT BLOWER MOTOR SWITCH 2. TURN BLOWER SWITCH ON, WIRE GOING TO COMPRESSOR SHOULD BE ENERGIZED
4. CHECK THERMOSTAT CONTROL OR SELECTOR LEVER	1. TURN THERMOSTAT CONTROL TO "COLD" POSITION OR SELECTOR LEVER TO "AIR CONDITION" POSITION 2. CHECK CURRENT FOR THE SWITCH
5. CHECK COMPRESSOR CIRCUIT CONTINUITY	1. CHECK COMPRESSOR SAFETY SWITCH, IF APPLICABLE 2. CHECK CURRENT AT COMPRESSOR 3. CHECK GROUND WIRE AT COMPRESSOR NOTE: IF WIRE CONNECTION AT COMPRESSOR IS ENERGIZED AND GROUND WIRE IS PROPERLY CONNECTED, COMPRESSOR CLUTCH SHOULD "KICK IN"

STEPS	KEY POINTS
	NOTE: SOME AIR CONDITIONING SYSTEMS HAVE ADDITIONAL COMPONENTS; IF SO, SPECIFIC SERVICE MANUALS SHOULD BE USED
6. CLEAN WORK STATION	REFER TO IX-A-1(TS)

TASK: CHECK AIR DIVERTER DOORS (MANUAL OPERATED)

JOB: DIAGNOSE AIR CONDITIONING CONTROLS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: RAGS, FENDER COVERS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. PLACE VEHICLE IN WORK STALL 2. SET EMERGENCY BRAKE 3. USE FENDER COVER 4. DISCONNECT NEGATIVE BATTERY CABLE
2. CHECK DIVERTER DOORS (MANUAL OPERATION) A. TEMPERATURE DIVERTER DOOR	NOTE: THIS PROCEDURE WILL COVER THE MANUAL TYPE WAY OF CONTROLLING TEMPERATURE THROUGH THE USE OF CONTROL CABLES 1. CHECK CONTROL CABLE ATTACHMENT AT AIR CONDITIONING CONTROL PANEL (TEMPERATURE LEVER) NOTE: RETAINER CLIPS SOMETIMES WORK LOOSE 2. CHECK ROUTING OF CABLE ASSEMBLY FOR KINKS OR BINDING OF CONTROL CABLE 3. CHECK FOR PROPER ATTACHMENT OF CABLE AT DIVERTER DOOR 4. MOVE TEMPERATURE SELECTOR LEVER ON AIR CONDITIONING CONTROL PANEL, AIR DIVERTER DOOR SHOULD MOVE ACCORDINGLY NOTE: MOVEMENT OF THE TEMPERATURE AIR DIVERTER DOOR REGULATES THE AMOUNT OF AIR CONDITIONED AIR THAT IS ALLOWED TO ENTER THE PASSENGER COMPARTMENT
B. POSITION SELECTOR DIVERTER DOOR	1. NOTE: THE FOLLOWING PROCEDURE WILL COVER THE MANUAL TYPE WAY OF CONTROLLING THE DIRECTION OF AIR FLOW 1. POSITION SELECTOR SHAFT WILL

STEPS	KEY POINTS
	USUALLY HAVE 3 POSITIONS-DEFROST, AIR CONDITION, AND HEATER 2. CHECK CONTROL CABLE ATTACHMENT AT CONTROL PANEL NOTE: RETAINER CLIPS SOMETIMES WORK LOOSE 3. CHECK ROUTING OF CABLE ASSEMBLY FOR KINKS OR BINDING OF CONTROL CABLE 4. CHECK FOR PROPER ATTACHMENT OF CABLE AT DIVERTER DOOR 5. MOVE POSITION SELECTOR LEVER ON CONTROL PANEL, AIR DIVERTER DOOR SHOULD MOVE ACCORDINGLY NOTE: CHECK AIR DUCTS FOR FOREIGN MATERIAL LODGED AGAINST AIR DIVERTER DOOR, PREVENTING PROPER OPERATION NOTE: SOME AIR CONDITIONING SYSTEMS HAVE ADDITIONAL COMPONENTS AND CONTROLS; IF SO, SPECIFIC SERVICE MANUALS SHOULD BE USED 6. RECONNECT NEGATIVE BATTERY CABLE
3. CLEAN WORK STATION	REFER TO IX-A-1(TS)

TASK: CHECK AIR DIVERTER DOORS (VACUUM OPERATED)

JOB: DIAGNOSE AIR CONDITIONING CONTROLS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: VACUUM HAND PUMP, VACUUM GAGE, FENDER COVERS, RAGS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. PLACE VEHICLE IN WORK STALL 2. SET EMERGENCY BRAKE 3. USE FENDER COVERS
2. CHECK DOOR OPERATION	NOTE: THIS PROCEDURE COVERS THE VACUUM (PNEUMATIC) OPERATED WAY OF CONTROLLING AIR DIVERTER DOORS. NO CONTROL CABLES ARE USED CAUTION: ENGINE MUST BE RUNNING DURING THIS TEST. BE CAREFUL NOT TO SHIFT TRANSMISSION INTO GEAR 1. START ENGINE TO PROVIDE VACUUM SOURCE 2. CHECK VACUUM HOSE CONNECTION AT VACUUM SOURCE (ENGINE) 3. CHECK VACUUM RESERVE TANK FOR PROPER CONNECTION AND VACUUM LEAKS 4. CHECK AIR CONDITIONING CONTROL ASSEMBLY FOR PROPER CONNECTION OF VACUUM HOSES AND VACUUM LEAKS 5. CHECK ALL HOSE ROUTING 6. CHECK ALL HOSES FOR CRACKS, SPLITS, OR DETERIORATION NOTE: AS CONTROL LEVERS ARE ACTUATED, VACUUM IS DIRECTED TO ACTUATOR AIR VALVES 7. CHECK ACTUATOR AIR VALVES FOR VACUUM LEAKS (USE VACUUM HAND PUMP) 8. CHECK FOR PROPER ATTACHMENT OF ACTUATOR LEVERS FROM ACTUATOR AIR VALVES TO AIR DIVERTER DOORS 9. MOVE CONTROL LEVER TO SELECTED

STEPS	KEY POINTS
	POSITIONS, AIR DIVERTER DOORS SHOULD MOVE ACCORDINGLY NOTE: CHECK AIR DUCTS FOR FOREIGN MATERIAL LODGED AGAINST DIVERTER DOORS, PREVENTING PROPER OPERATION NOTE: EACH AIR CONDITIONING CONTROL SYSTEM WILL VARY AS TO THE LOCATION AND OPERATION OF AIR DIVERTER DOORS. SERVICE MANUALS PERTAINING TO SPECIFIC MODELS SHOULD BE USED WHENEVER POSSIBLE
3. CLEAN WORK STATION	REFER TO IX-A-1(TS)

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INSTRUCTOR'S PLAN IX-A-6(I)
INFORMATIONAL LESSON

SUBJECT: SERVICE EQUIPMENT

AIM: THE STUDENT WILL BE ABLE TO IDENTIFY AND EXPLAIN THE PROPER USE AND CARE OF THE BASIC TOOLS AND EQUIPMENT REQUIRED TO TEST AND SERVICE AN AUTOMOTIVE AIR CONDITIONING SYSTEM.

TEACHING AIDS: VACUUM PUMP, GAUGE AND MANIFOLD SET, LEAK DETECTOR KIT, SERVICE VALVES, CHARTS, OVERHEAD PROJECTOR, AND TRANSPARENCIES I. ED. IX T FIGURES 35-45

MATERIALS: CHALKBOARD

REFERENCES: AUTOMOTIVE SERVICE AND REPAIR, CH. 32
AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646
FUNDAMENTALS OF SERVICE AIR CONDITIONING, PP. 33-39
AUTOMOTIVE AIR CONDITIONING, PP. 61-67
INFORMATION SHEET

I. PREPARATION (OF THE LEARNER - MOTIVATION)

THE TESTING AND SERVICING OF AN AIR CONDITIONING SYSTEM REQUIRES BASIC TOOLS AND EQUIPMENT. ACCURATE TESTING OF THE SYSTEM REQUIRES THE USE OF TEST GAUGES THAT CAN PINPOINT TROUBLE WITHIN THE SYSTEM AS WELL AS DETERMINE IF THE SYSTEM IS PERFORMING AS IT SHOULD.

LEAK DETECTORS PROVIDE THE SERVICEMAN WITH A MEANS OF CHECKING ALL COMPONENTS FOR ANY LEAKS. THERE ARE DIFFERENT METHODS OF CHECKING FOR LEAKS, RANGING FROM THE USE OF SOAP TO EXPENSIVE ELECTRONIC INSTRUMENTS.

THE REFRIGERANT SYSTEM, WHEN DEPRESSURIZED AND OPENED FOR SERVICE, ENCOUNTERS AIR AND MOISTURE ENTERING THE SYSTEM. BECAUSE OF THE HARMFUL EFFECT OF THE MOISTURE, THE AIR MUST BE REMOVED. THIS IS DONE BY EVACUATING THE SYSTEM WITH A VACUUM PUMP.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. GAUGE AND MANIFOLD SET	1. CONSIST OF A MANIFOLD AND EITHER TWO OR THREE GAUGES NOTE: CHRYSLER AIR-TEMP AND GENERAL MOTORS REQUIRE A THREE GAUGE MANIFOLD
SHOW TRANSPARENCY: FIGURE 35	2. FUNCTIONS OF THE GAUGE MANIFOLD SET:

a. BLEED EXCESS REFRIGERANT FROM THE SYSTEM
b. BLEED AIR FROM THE SYSTEM
c. PURGE REFRIGERANT BEFORE SERVICE WORK
d. REMOVE AIR AND MOISTURE DURING PUMP DOWN
e. CHARGE SYSTEM WITH REFRIGERANT
f. CHECK SYSTEM'S PERFORMANCE
g. DIAGNOSE PROBLEMS OF THE SYSTEM

1. LOW SIDE GAUGE (COMPOUND GAUGE)

SHOW TRANSPARENCY: FIGURE 36

1. CONNECTED TO THE LOW SIDE OF THE SYSTEM
2. REGISTERS BOTH PRESSURE AND VACUUM
   NOTE: AIR CONDITIONERS UNDER CERTAIN CONDITIONS DROP FROM A PRESSURE INTO A VACUUM ON THE LOW SIDE
3. VACUUM SCALE IS CALIBRATED TO READ FROM 0 TO 30 INCHES OF MERCURY (0" TO 30" Hg)
4. PRESSURE READING CALIBRATED TO READ MINIMUM OF 80 PSI, BUT CONSTRUCTED TO WITHSTAND 250 PSI.
   CAUTION: IF THE MANIFOLD IS HOOKED UP BACKWARD THE PRESSURE WOULD EXCEED THIS

2. HIGH SIDE GAUGE (HIGH PRESSURE)

1. USED TO DETERMINE PRESSURE ON HIGH SIDE
2. GAUGE IS CALIBRATED FROM 0 PSI TO MINIMUM OF 300 PSI
   NOTE: A TOP SCALE OF 400 TO 500 PSI IS PREFERABLE

3. MANIFOLD

1. CONNECTS GAUGES TO THE AIR CONDITIONING SYSTEM
2. CONTAINS FITTINGS FOR BOTH GAUGES AND HOSES TO CONNECT TO THE MANIFOLD AND SYSTEM
   NOTE: GAUGES ARE MOUNTED TO MANIFOLD BY USE OF A 1/8" PIPE CONNECTION

NOTE: SERVICE HOSES ARE CONNECTED TO THE MANIFOLD WITH A 1/8" MALE PIPE FITTING AND WITH 1/4" MALE FLARE ADAPTERS

NOTE: THE HOSES ARE CONNECTED TO THE COMPRESSOR SERVICE VALVES WITH A 1/4" FEMALE FLARE FITTING

3. THE LOW SIDE HOSE AND FITTING IS FASTENED DIRECTLY BELOW THE LOW SIDE GAUGE
4. THE HIGH SIDE HOSE AND FITTING IS FASTENED DIRECTLY BELOW THE HIGH SIDE GAUGE
5. THE CENTER PORT (FITTING) IS LOCATED BETWEEN THE LOW AND HIGH SIDE PORTS

NOTE: CENTER PORT IS NOT CONNECTED TO THE AIR CONDITIONING SYSTEM, BUT IS USED TO PURGE THE REFRIGERANT OR TO EVACUATE THE SYSTEM

6. CONTAINS HAND SHUTOFF VALVES ON EACH END TO CONTROL THE FLOW OF REFRIGERANT INTO THE HIGH AND LOW SIDE

SHOW TRANSPARENCY: FIGURE 37

a. WHEN THE SHUTOFF VALVE IS CLOSED, REFRIGERANT WILL BE CUT OFF FROM THE CENTER TEST HOSE, BUT WILL FLOW TO THE GAUGES. A PRESSURE READING WILL REGISTER ON THE GAUGE

NOTE: THE PRESSURE ON THE SIDE CLOSED WILL BE RECORDED ON THAT GAUGE

SHOW TRANSPARENCY: FIGURE 38

b. CRACKING THE VALVE, IN THE COUNTERCLOCKWISE DIRECTION, OPENS THE SYSTEM TO THE MIDDLE SERVICE PORT

NOTE: THIS IS DESIRABLE WHEN IT IS NECESSARY TO LET REFRIGERANT INTO OR OUT OF THE SYSTEM

c. WHEN THE HAND VALVE ON THE LOW SIDE IS CRACKED, THE ACTION TAKES PLACE BETWEEN THE LOW SIDE AND CENTER PORT ONLY. THE

LOW SIDE GAUGE WILL RECORD LOW SIDE PRESSURE ONLY

NOTE: THE HIGH SIDE REMAINS CLOSED AND PRESSURE READ ON THE HIGH SIDE GAUGE WILL BE HIGH SIDE PRESSURE ONLY

SHOW TRANSPARENCY: FIGURE 39

d. CRACKING BOTH MANIFOLD HAND VALVES WILL GIVE A PRESSURE READING ON BOTH GAUGES

NOTE: THE PRESSURE READINGS WILL NOT BE CORRECT

NOTE: BOTH VALVES WILL BE CRACKED WHEN DISCHARGING OR EVACUATING THE SYSTEM

B. TEST HOSES
SHOW SAMPLES OF HOSES

1. CONNECTION BETWEEN THE GAUGE MANIFOLD AND SYSTEM
2. CONNECTIONS ARE SCREW-ON TYPE SEALED WITH AN INTERNAL O-RING
NOTE: HOSE CONNECTIONS SHOULD BE HAND TIGHTENED ONLY
3. AVAILABLE TO FIT THE SERVICE CONNECTORS WITH A SCHRADER VALVE
NOTE: SOME REQUIRE THE USE OF A SCHRADER VALVE ADAPTER ON THE CONNECTORS BEFORE USING THE SCHRADER VALVE

C. SERVICE VALVES

SHOW TRANSPARENCIES: FIGURES 40 - 42

1. INSTALLED IN THE COMPRESSOR HEAD TO MAKE CONNECTIONS WITH THE EVAPORATOR AND CONDENSER
2. MANIFOLD SERVICE HOSES CONNECT TO THE SERVICE VALVE PORTS
3. PERMITS SERVICING OF REFRIGERANT AND CONNECTION OF GAUGES FOR CHECKING SYSTEM PERFORMANCE
4. COMPRESSOR IS EQUIPPED WITH TWO VALVES
   a. HIGH PRESSURE VALVE ON THE COMPRESSOR DISCHARGE SIDE (ROUTED TO THE CONDENSER)
   b. LOWER PRESSURE VALVE ON THE INLET SIDE (ROUTED TO THE EVAPORATOR)
5. TWO TYPES OF VALVES
   a. HAND SHUTOFF VALVE

b. SCHRADER VALVE

1. HAND OPERATED SHUTOFF VALVES
   1. DOES NOT REQUIRE SCHRADER VALVE
   2. CONTAINS THREE OPERATIONAL POSITIONS
      a. PACK SEATED (OPERATIONAL)
      b. MIDPOSITION (CRACKED)
      c. FRONT SEATED (ALL FLOW SHUT OFF)

   a. BACK SEATED
      1. SEALS THE COMPRESSOR AND COMPRESSOR PORT FROM GAUGE PORT
      2. REFRIGERANT IS FREE TO FLOW IF THE COMPRESSOR IS STARTED
      3. PRESSURE READINGS CANNOT BE TAKEN
      NOTE: ALL SERVICE VALVES SHOULD BE IN THIS POSITION WHEN THE SYSTEM IS OPERATING NORMALLY

   b. MIDPOSITION (CRACKED)
      1. VALVE DOES NOT SEAL AGAINST EITHER SEAT
      2. USED TO CHARGE OR DISCHARGE SYSTEM
      3. SYSTEM CAN BE OPERATED AND PRESSURES RECORDED THROUGH THE GAUGE PORT OPENINGS
      NOTE: VALVES MUST BE BACK SEATED BEFORE REMOVAL OF THE GAUGE HOSES

   c. FRONT SEATED
      1. COMPRESSOR PORT IS CLOSED OFF FROM THE VALVE
      NOTE: WITH BOTH SERVICE VALVES IN THIS FRONT SEATED POSITION, THE COMPRESSOR IS ISOLATED FROM THE REST OF THE SYSTEM AND IS CONNECTED ONLY TO THE GAUGE PORTS
      2. COMPRESSOR MAY BE SERVICED WITHOUT DISCHARGING OR DISTURBING THE REST OF THE SYSTEM
      CAUTION: NEVER OPERATE A COMPRESSOR WITH THE SERVICE VALVES IN CLOSED OR FRONT SEATED POSITION; THIS WILL DAMAGE THE COMPRESSOR

2. SCHRADER VALVE
   1. WHEN USED IN THE SERVICE CONNECTOR ELMINATES THE NEED FOR A SERVICE VALVE IN THE SYSTEM

2. BOTH VALVES MAY BE LOCATED ON THE SUCTION SIDE AND ONE ON THE DISCHARGE SIDE
   NOTE: ONE SCHRADER VALVE MAY BE LOCATED ON THE SUCTION THROTTLING VALVE AND THE OTHER ON THE COMPRESSOR DISCHARGE SIDE
3. SPECIAL ADAPTER IS REQUIRED TO CONNECT THE MANIFOLD GAUGE SET LINES TO THE SCHRADER VALVES
   NOTE: ADAPTER HAS PIN THAT DEPRESSES THE CENTER OF SCHRADER VALVE TO ALLOW PRESSURE READINGS ON THE GAUGES
4. CONTAINS ONLY TWO POSITIONS
   a. CRACKED
   b. BACK SEATED
5. GAUGE LINES SHOULD BE DISCONNECTED FROM SCHRADER VALVES BY DISCONNECTING THE ADAPTER FROM THE VALVE FIRST
   CAUTION: DO NOT DISCONNECT THE ADAPTER FROM THE GAUGE LINE UNTIL THE ADAPTER IS REMOVED FROM THE VALVE
6. MANIFOLD GAUGE VALVES MUST BE OFF BEFORE CONNECTING GAUGE LINES TO SCHRADER VALVES

D. LEAK DETECTORS

THERE ARE SEVERAL TYPES OF LEAK DETECTORS AVAILABLE FOR CHECKING LEAKS IN THE SYSTEM

1. COLORED DYE ADDITIVE SHOW SAMPLE

1. DYE ADDITIVE IS ADDED TO THE REFRIGERANT
   NOTE: RED OR YELLOW COLORED DYE
2. DURING SYSTEM OPERATION POINT OF LEAKAGE BECOMES DISCOLORED
3. EFFECTIVE METHOD FOR VERY SLIGHT LEAKS, SUCH AS "COLD" LEAKS OR "PRESSURE" LEAKS
4. VEHICLE IS DRIVEN A FEW DAYS BEFORE LEAK IS DETECTED

2. LIQUID DETERGENT SHOW SAMPLE

1. USED AROUND CONNECTIONS AND EXTERNAL POINTS THAT MAY BE SOURCE OF LEAK

2. LIQUID WILL BUBBLE AT POINT OF LEAK
3. NOT APPLICABLE TO CHECK INACCESSIBLE LEAKS SUCH AS THE COILS IN THE CONDENSER AND EVAPORATOR
4. MIXTURE IS ONE-HALF CUP OF DETERGENT WITH WATER TO FORM A THICK SOLUTION

3. ELECTRONIC LEAK DETECTOR

1. MOST SENSITIVE DETECTOR ON THE MARKET
2. VERY EXPENSIVE IN THE INITIAL COST
3. VERY SENSITIVE AND MUST BE HANDLED AND USED CAREFULLY

SHOW TRANSPARENCY: FIGURE 43

4. WILL DETECT REFRIGERANT LOSS AS SLOW AS ONE-HALF OUNCE PER YEAR
5. ELECTRONIC LEAK DETECTOR MODELS AVAILABLE
   a. GENERAL ELECTRIC TYPE H-10 THAT OPERATES ON 120 VOLTS, 60 CYCLE
   b. CORDLESS TYPE H-11, A PORTABLE, CORDLESS MODEL THAT OPERATES FROM A RECHARGEABLE BATTERY
   c. 508 TIF BY THERMAL INDUSTRIES, THAT IS POWERED BY TWO ORDINARY FLASHLIGHT BATTERIES

4. HALIDE GAS TORCH

1. TYPES OF HALIDES TORCHES
   a. PROPANE
   b. ALCOHOL
2. MOST COMMON LEAK DETECTOR USED
   a. EASE OF HANDLING
   b. AVAILABILITY OF GAS CYLINDERS
   c. LOW INITIAL AND OPERATIVE COST

SHOW TRANSPARENCY: FIGURE 44

3. WILL DETECT A LEAK AS SLIGHT AS ONE POUND OF REFRIGERANT IN TEN YEARS
4. THE HALIDE TORCH CONSISTS OF TWO MAJOR PARTS:
   a. DETECTOR - VALVE, CONTROL KNOB, BURNER, AND SEARCH HOSE (SNIFFER TUBE)
   b. CYLINDER - NONREFILLABLE PRESSURE TANK CONTAINING GAS, EITHER PROPANE OR ALCOHOL
5. FLAME CHANGES COLOR AS REFRIGERANT LEAK IS DETECTED

CAUTION: USED HALIDE DETECTOR ONLY IN WELL VENTILATED SPACES; THE BURNING REFRIGERANT GIVES OFF A POISONOUS PHOSGENE GAS

6. LEAK DETECTION MUST BE PERFORMED WITH SYSTEM UNDER PRESSURE

E. VACUUM PUMP

1. USED TO REMOVE MOISTURE AND AIR FROM SYSTEM

SHOW TRANSPARENCY: FIGURE 45

2. THE MOST EFFICIENT METHOD OF MOISTURE REMOVAL
3. MOISTURE IS REMOVED BY CREATING A VACUUM WITHING THE SYSTEM

NOTE: VACUUM PUMP PULLS DOWN PRESSURE TO 29.76" Hg OR BETTER, THEREBY CAUSING MOISTURE TO BOIL OUT OF THE SYSTEM

4. AMOUNT OF MOISTURE REMOVED IS DETERMINED BY:
   a. AMOUNT OF VACUUM PULLED
   b. LENGTH OF TIME SYSTEM IS SUBJECTED TO VACUUM

NOTE: MINIMUM TIME LENGTH 30 MINUTES WITH FOUR HOURS RECOMMENDED TIME LENGTH

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

QUESTIONS FOR DISCUSSION:

1. WHAT THREE BASIC TOOLS ARE REQUIRED TO TEST AND SERVICE AN AIR CONDITIONING SYSTEM?

ANSWER: 1. GAUGE AND MANIFOLD SET
2. LEAK DETECTOR
3. VACUUM PUMP

2. WHY ARE TWO GAUGES NEEDED TO TEST THE PRESSURE IN THE SYSTEM?

ANSWER: ONE FOR THE HIGH SIDE, AND ONE FOR THE LOW SIDE OF THE SYSTEM

3. ON WHAT COMPONENTS ARE THE SYSTEM SERVICE VALVES LOCATED?

ANSWER: THE COMPRESSOR

4. WHAT ARE FOUR METHODS OF TESTING FOR LEAKS?

ANSWER: 1. COLORED DYE ADDITIVE
2. LIQUID DETERGENT
3. HALIDE GAS TORCH LEAK DETECTOR
4. ELECTRONIC LEAK DETECTOR

5. WHAT TYPE LEAK DETECTOR IS MOST SENSITIVE TO SMALL LEAKS?

ANSWER: ELECTRONIC LEAK DETECTOR

6. WHAT EQUIPMENT IS USED TO REMOVE AIR FROM THE SYSTEM?

ANSWER: A VACUUM PUMP

7. WHAT ARE TWO TYPES OF SERVICE VALVES USED TO CONNECT THE MANIFOLD GAUGE SET INTO THE SYSTEM?

ANSWER: 1. HAND SHUTOFF VALVE
2. SCHRADER VALVE

8. WHAT TWO FUNCTIONS DOES THE COMPOUND GAUGE PERFORM THAT ITS NAME IS DERIVED FROM?

ANSWER: 1. REGISTERS PRESSURE IN PSI
2. REGISTERS VACUUM IN INCHES OF MERCURY (Hg) VACUUM

9. WHAT HAPPENS WHEN REFRIGERANT-12 IS PASSED OVER AN OPEN FLAME?

ANSWER: IT GIVES OFF A POISONOUS PHOSGENE GAS

10. WHAT METHOD OF LEAK DETECTION IS MOST POPULAR?

ANSWER: THE HALIDE GAS TORCH DETECTOR

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

TRUE OR FALSE

1. THE VACUUM PUMP IS USED TO PUMP REFRIGERANT INTO THE SYSTEM. F
2. THE HALIDE GAS LEAK DETECTOR IS THE MOST COMMONLY USED DETECTOR. T
3. THE COLOR OF THE FLAME ON A HALIDE DETECTOR CHANGES WITH THE AMOUNT OF LEAKING REFRIGERANT DETECTED. T
4. ELECTRONIC LEAK DETECTORS ARE AVAILABLE ONLY IN RECHARGEABLE BATTERIES AND FLASHLIGHT BATTERY MODELS. F
5. THE REFRIGERATION SYSTEM MUST BE UNDER PRESSURE WHEN PERFORMING A LEAK TEST WITH THE HALIDE DETECTOR. T

6.	"COLD" LEAKS OR "PRESSURE" LEAKS ARE EFFECTIVELY LOCATED USING THE COLORED DYE ADDITIVE METHOD.	T
7.	WHEN THE HAND OPERATED SHUTOFF VALVE IS IN THE BACK SEATED POSITION, ALL FLOW OF REFRIGERANT IS SHUT OFF.	F
8.	THE MIDPOSITION (CRACKED) OF THE SERVICE VALVE IS USED TO CHARGE OR DISCHARGE THE SYSTEM.	T
9.	THE "HIGH PRESSURE" SERVICE VALVE IS LOCATED ON THE INLET SIDE OF THE COMPRESSOR.	F
10.	THE LOW SIDE GAUGE REGISTERS BOTH PRESSURE AND VACUUM.	T
11.	THE SCHRADER VALVE ELIMINATES THE NEED FOR USING HAND SHUTOFF SERVICE VALVES.	T
12.	THE USE OF THE SCHRADER VALVE REQUIRES A SPECIAL ADAPTER TO CONNECT THE VALVE TO THE MANIFOLD GAUGE HOSES.	T
13.	THE SCHRADER VALVE CANNOT BE POSITIONED IN A BACK SEATED POSITION.	F
14.	THE VACUUM PUMP, BY PULLING DOWN THE PRESSURE IN THE SYSTEM, CAUSES MOISTURE IN THE SYSTEM TO BOIL OUT.	T
15.	THE AMOUNT OF MOISTURE REMOVED FROM THE SYSTEM WILL BE DETERMINED BY THE AMOUNT OF VACUUM PULLED AND BY THE LENGTH OF TIME THE SYSTEM IS SUBJECTED TO THE VACUUM.	T

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

AIR CONDITIONING MANIFOLD GAUGE SETS ARE A NECESSITY IN THE DIAGNOSING AND SERVICING OF THE AIR CONDITIONING SYSTEM. THE MANIFOLD GAUGE SET CONSISTS OF GAUGE VALVES AND GAUGES BOTH HIGH AND LOW PRESSURE, AND THREE OUTLET CONNECTIONS WITH HOSES. SOME UNITS REQUIRE A THREE GAUGE SYSTEM WHICH HAS AN ADDITIONAL LOW PRESSURE GAUGE. THE LOW PRESSURE GAUGE IS GRADUATED INTO PSI AND INCHES OF VACUUM AND IS CONNECTED TO THE SYSTEM SUCTION LINE. THE HIGH PRESSURE GAUGE IS GRADUATED IN PSI AND CONNECTED TO THE DISCHARGE LINE. THE CENTER CONNECTION OR HOSE IS ATTACHED TO THE VACUUM PUMP, REFRIGERANT OR REFRIGERATION OIL, AND IS USED FOR CHARGING AND EVALUATING PROCEDURES.

SERVICE VALVES ARE INSTALLED IN THE COMPRESSOR TO MAKE CONNECTIONS WITH THE EVAPORATOR AND CONDENSER. THE MANIFOLD SERVICE HOSES

CONNECT TO THE SERVICE VALVES, THEREBY PERMITTING SERVICING AND CHECKING THE SYSTEM'S PERFORMANCE. THERE ARE TWO TYPES OF SERVICE VALVES, THE MOST COMMON BEING THE HAND SHUTOFF VALVE AND THE SCHRADER VALVE. THE HAND SHUTOFF VALVE HAS THREE POSITIONS, BACK SEATED, CRACKED, AND FRONT SEATED. THE SCHRADER CONTAINS ONLY TWO POSITIONS, CRACKED AND BACK SEATED.

LEAK DETECTORS ARE ESSENTIAL FOR CHECKING LEAKS IN THE SYSTEM. THERE ARE FOUR METHODS OF CHECKING FOR LEAKS: (1) HALIDE GAS TORCH; (2) ELECTRONIC DETECTOR; (3) COLORED DYE ADDITIVE; AND (4) LIQUID DETERGENT. THE MOST COMMONLY USED IS THE HALIDE GAS TORCH WHICH LOCATES A LEAK BY DRAWING THE REFRIGERANT INTO THE SNIFFING OR SAMPLING HOSE. THE REFRIGERANT GAS WILL CAUSE THE FLAME TO CHANGE COLOR IN PROPORTION TO SIZE OF THE LEAK.

THE ELECTRONIC DETECTOR, WHICH INCORPORATES A SMALL PICKUP TUBE, VACUUM PUMP, AND A SENSOR, WILL DETECT EXTREMELY SMALL LEAKS. AS THE LEAK IS DETECTED, A POPPING OR SQUEALING SOUND IS DETECTED.

WHEN THE SYSTEM IS DEPRESSURIZED AND OPENED FOR SERVICE, AIR (WHICH CONTAINS MOISTURE) ENTERS THE OPENINGS BEFORE THEY CAN BE CAPPED, TO REMOVE THIS AIR REQUIRES EVACUATING THE SYSTEM. THIS IS DONE BY REMOVING AIR UNTIL A VACUUM IS CREATED. THE VACUUM PUMP IS USED TO EVACUATE THE AIR FROM THE SYSTEM. THE PUMP PULLS DOWN THE PRESSURE BELOW 29.76 INCHES Hg, THEREBY LOWERING THE BOILING POINT OF WATER. THIS CAUSES THE MOISTURE TO BOIL OUT. THE AMOUNT OF MOISTURE REMOVED IS DETERMINED BY: (1) THE AMOUNT OF VACUUM PULLED AND (2) THE LENGTH OF TIME THE SYSTEM IS SUBJECTED TO VACUUM. THE MINIMUM TIME IS ABOUT THIRTY MINUTES WITH THE RECOMMENDED TIME FOUR HOURS.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, PP.
AUTO SERVICE AND REPAIR, PP. 32-10 TO 32-14
AUTOMOTIVE SERVICE MANUALS
FUNDAMENTALS OF SERVICE AIR CONDITIONING, PP. 33-39
AUTOMOTIVE AIR CONDITIONING, PP. 58-71

THE NEXT LESSON IS: IX-A-7(I) "AIR CONDITIONING DIAGNOSIS"

INFORMATION SHEET IX-A-4(IS)
ON
AIR CONDITIONING DIAGNOSIS

SUBJECT: Performance Chart

INTRODUCTORY INFORMATION:

Before repairs can be made on any component, whether it be on air conditioning, brakes, or radio, a diagnosis of the problem is essential. After properly diagnosing the problem, the mechanic can repair the defective component without stumbling around hoping to fix the right part. The following contains a list of discrepancies with possible cause and also corrective suggestions. Many of the performance test problems can be diagnosed by using the test chart; however, some problems will be different from those listed and should be referred to the manufacturer's repair manuals.

GENERAL INFORMATION:

DIAGNOSIS OF PERFORMANCE TEST RESULTS

CONDITION AND CAUSE	CORRECTION
High Pressure Side of System Too High	
A. Engine overheating	A. Check cooling system and related components
B. Too much refrigerant charge	B. Discharge part of refrigerant, recheck pressure reading
C. Restricted air flow through condenser	C. Clear material causing restriction
D. Too much oil in system	D. Drain and fill to proper level
E. Restriction in line or component	E. Check receiver/dehydrator, expansion valve screen, lines for kinks-blow out system, recheck
High Pressure Side of System Too Low	
A. Low refrigerant charge	A. Add to proper amount
B. Compressor valves leaking	B. Repair compressor as needed
C. Expansion valve or suction throttling valve stuck open	C. Replace valve
D. Compressor belt loose	D. Replace or tighten as necessary

Low Pressure Side of System Too High

A. Compressor belt loose	A. Replace or tighten as necessary
B. Defective suction throttling valve	B. Replace valve
C. Restriction in suction line	C. Repair restriction
D. Excessive refrigerant charge	D. Partial drain and recheck
E. Possible defective expansion valve	E. Replace valve
F. Defective compressor valves	F. Repair compressor as necessary

Low Pressure Side of System Too Low

A. Low refrigerant charge	A. Charge system to proper level
B. Restricted air flow through evaporator	B. Remove material causing restriction
C. Possible defective suction throttling valve	C. Replace valve
D. Defective expansion valve	D. Replace valve
E. Restriction in system	E. Check receiver/dehydrator, expansion valve screen, or lines for kinks
F. Clutch will not disengage	F. Repair faulty component

Discharge Air Too Warm (Pressure Readings OK)

A. Low refrigerant charge	A. Charge system to proper level
B. Air ducts not properly connected	B. Repair and connect as needed
C. Temperature control cable inoperative	C. Adjust or replace as necessary, check air doors for obstructions
D. Poor seal around evaporator case	D. Seal as necessary
E. Vacuum controls inoperative	E. Locate problem and repair
F. Heater discharging warm air	F. Repair controls or air doors adjustment

Noisy Air Conditioning System

A. Blower motor defective	A. Replace blower motor
B. Foreign material in blower motor	B. Remove as necessary
C. Compressor belt loose	C. Tighten or replace belt
D. Compressor internal noise	D. Repair or replace compressor
E. Compressor mounting loose	E. Tighten as necessary
F. Lines vibrating	F. Secure with clamps
G. Expansion valve or suction throttling valve defected	G. Replace valve

Air Flow At Discharge Nozzle Too Low

A. Blower motor defected	A. Replace blower motor
B. Restricted air ducts	B. Inspect and repair as needed
C. Restricted evaporator	C. Remove foreign material
D. Air doors inoperative	D. Repair or remove foreign material
E. Defective controls or wiring	E. Repair defective components

AIR CONDITIONING DIAGNOSIS PERFORMANCE CHART

In Front Of Condenser		Evaporator Pressure At		Discharge Air Temp. Left Center Outlet	Pressure High (Discharge)
Relative Humidity	Air Temp. °F. ±1 PSI	Gauge Connection	Engine RPM	±2°F.	±20 PSI
30	70	29.5	2000	42	190
	80	30.5		48	230
	90	32.5		54	295
	100	39.0		64	370
40	70	29.5	2000	45	175
	80	31.5		52	240
	90	34.0		59	310
	100	42.0		69	380
50	70	29.5	2000	46	185
	80	32.5		54	250
	90	36.0		62	320
	100	42.5		71	385
60	70	29.5	2000	47	190
	80	33.5		56	250
	90	38.0		64	325
	100	43.5		72	390
70	70	29.5	2000	48	200
	80	34.5		57	265
	90	40.0		67	335
80	70	29.5	2000	49	210
	80	35.0		58	280
	90	43.0		71	350
90	70	29.5	2000	50	220
	80	36.5		59	290
	90	44.0		72	360

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INSTRUCTOR'S PLAN IX-A-7(I)
INFORMATIONAL LESSON

SUBJECT: AIR CONDITIONING DIAGNOSIS

AIM: THE STUDENT WILL BE ABLE TO IDENTIFY THE CONDITIONS THAT MAY CAUSE THE AIR CONDITIONING SYSTEM TO PERFORM INADEQUATELY AND BE ABLE TO RECOGNIZE THE EFFECT THAT CONDITION HAS ON THE SYSTEM.

TEACHING AIDS: TRANSPARENCIES I. ED. X T, FIGURES 46-55
INFORMATION SHEET IX-A-5(IS), "PERFORMANCE CHART"

MATERIALS: CHALK

REFERENCES: AUTOMOTIVE ENCYCLOPEDIA
AUTOMOTIVE MECHANICS, CH. 43
FUNDAMENTALS OF SERVICE AIR CONDITIONING

PREREQUISITE EXPERIENCE OF THE LEARNER: THE STUDENT MUST HAVE SUCCESSFULLY COMPLETED PREVIOUS LESSONS IN BLOCK IX.

I. PREPARATION (OF THE LEARNER-MOTIVATION)

TO DETERMINE THE OPERATING EFFICIENCY OF THE AIR CONDITIONING SYSTEM FOR THE PURPOSE OF SERVICING THE SYSTEM OR DETERMINING A MALFUNCTION IN THE SYSTEM CAN BE A LENGTHY AND COSTLY PROCESS UNLESS A LOGICAL DIAGNOSTIC PROCEDURE IS FOLLOWED.

WHEN A CUSTOMER COMES IN WITH A COMPLAINT, THE MECHANIC MUST BE ABLE TO DETERMINE THE PROBLEM QUICKLY AND ACCURATELY. THIS IS DONE BY MAKING A DIAGNOSTIC TEST OF THE SYSTEM BY USING THE MANIFOLD GAUGE SET TO CHECK THE OPERATING EFFICIENCY OF THE SYSTEM.

BY A VISUAL INSPECTION OF THE COMPONENTS, STUDIED IN PREVIOUS LESSONS, AND THE CORRECT INTERPRETATION OF GAUGE READINGS, AN ACCURATE DIAGNOSIS OF THE SYSTEM CAN BE MADE AND THE PROBLEM DETERMINED.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. LACK OF REFRIGERANT	NOTE: CUSTOMER WILL COMPLAIN OF LITTLE OR NO COOLING FROM THE EVAPORATOR
SHOW TRANSPARENCY: FIGURE 46	1. LOW SIDE GAUGE READING VERY LOW NOTE: PRESSURE SHOULD BE BETWEEN 7-30 PSI

2. HIGH SIDE GAUGE READING VERY LOW
   NOTE: PRESSURE SHOULD BE BETWEEN 185-205 AT 95°F
   NOTE: PRESSURE WILL CHANGE WITH DIFFERENT AMBIENT TEMPERATURE
3. SIGHT GLASS SHOWS NEITHER BUBBLES NOR LIQUID
4. DISCHARGE AIR FROM EVAPORATOR IS WARM
   NOTE: THIS CONDITION INDICATES SERIOUS REFRIGERANT LEAK

B. LOW REFRIGERANT CHARGE

NOTE: CUSTOMER COMPLAINS OF INADEQUATE COOLING

SHOW TRANSPARENCY: FIGURE 47

1. LOW SIDE READING IS TOO LOW
2. HIGH SIDE READING IS TOO LOW
3. BUBBLES ARE VISIBLE IN SIGHT GLASS
4. DISCHARGE AIR FROM EVAPORATOR IS SLIGHTLY COOL
   NOTE: THIS CONDITION IS COMMONLY CAUSED BY FAILURE IN OPERATING AIR CONDITIONER PERIODICALLY DURING WINTER OR HAVING A VERY SMALL LEAK

C. AIR IN SYSTEM

NOTE: CUSTOMER COMPLAINS OF TOO LITTLE COOLING

1. LOW SIDE PRESSURE READING REMAINS CONSTANT

SHOW TRANSPARENCY: FIGURE 48

   NOTE: PRESSURE SHOULD DROP UNTIL THERMOSTAT CONTROL CYCLES CLUTCH
2. HIGH SIDE PRESSURE READING IS SLIGHTLY HIGH
   NOTE: PRESSURE WILL BE SLIGHTLY LOWER IF LARGE FAN IS USED TO SUBSTITUTE RAM AIR
3. SIGHT GLASS SHOWS AN OCCASIONAL BUBBLE
4. SUCTION LINE IS WARM TO TOUCH RATHER THAN COOL
5. EVAPORATOR DISCHARGE AIR IS SLIGHTLY COOL
   NOTE: SHOULD HAVE A SHARP, COOL FEEL

NOTE: SYSTEM CONTAINS A NON-CONDENSIBLE SUCH AS AIR OR MOISTURE

D. COMPRESSOR MALFUNCTION

NOTE: SYSTEM NOT COOLING FOR COMFORT

1. LOW SIDE GAUGE READING TOO HIGH
2. HIGH SIDE GAUGE READING TOO LOW
3. SYSTEM IS FULLY CHARGED

NOTE: ABSENCE OF BUBBLES IN SIGHT GLASS

4. EVAPORATOR DISCHARGE AIR NOT SUFFICIENTLY COOL

NOTE: INDICATES INTERNAL LEAK IN COMPRESSOR AND MUST BE OVERHAULED

SHOW TRANSPARENCY: FIGURE 49

E. CONDENSER MALFUNCTION

NOTE: CUSTOMER COMPLAINS OF NO COOLING AND/OR ENGINE OVERHEATING

1. LOW SIDE GAUGE READING TOO HIGH
2. HIGH SIDE GAUGE READING TOO HIGH
3. OCCASIONAL BUBBLES IN SIGHT GLASS
4. LIQUID LINE VERY HOT
5. DISCHARGE AIR FROM EVAPORATOR IS WARM

NOTE: CONDITION INDICATES IMPROPER CONDENSER OPERATION

SHOW TRANSPARENCY: FIGURE 50

F. EXCESSIVE MOISTURE IN SYSTEM

NOTE: CUSTOMER COMPLAINS OF EARLY MORNING OR LATE EVENING COOLING BUT DOES NOT COOL DURING HOT PART OF DAY

1. LOW SIDE GAUGE READING MAY DROP INTO VACUUM WHILE TESTING
2. HIGH SIDE GAUGE READING WILL DROP IF LOW SIDE DROPS INTO VACUUM
3. EVAPORATOR DISCHARGE AIR FEELS SHARP AND COLD BUT WILL WARM WHILE LOW SIDE IS IN VACUUM

NOTE: CONDITION INDICATES A DRIER SATURATED WITH MOISTURE

SHOW TRANSPARENCY: FIGURE 51

G. SYSTEM CONTAMINATED WITH AIR

NOTE: CUSTOMER COMPLAINS THE EVAPORATOR IS NOT COOLING

1. LOW SIDE GAUGE READING IS TOO HIGH
2. HIGH SIDE GAUGE READING IS TOO HIGH
3. OCCASIONAL BUBBLES PRESENT IN SIGHT GLASS

SHOW TRANSPARENCY: FIGURE 52

4. EVAPORATOR DISCHARGE AIR IS NOT COOL

H. EXPANSION VALVE MALFUNCTION #1

SHOW TRANSPARENCY: FIGURE 53

NOTE: CUSTOMER COMPLAINS OF FAILURE OF AIR CONDITIONER TO COOL

1. LOW SIDE GAUGE READING IS TOO HIGH
2. HIGH SIDE GAUGE READING IS TOO HIGH
3. DISCHARGE AIR IS WARM
4. HEAVY SWEAT ON SUCTION HOSE
5. HEAVY SWEAT FROM EVAPORATOR

NOTE: CONDITION INDICATES EXPANSION VALVE FLOODING EVAPORATOR COIL

I. EXPANSION VALVE MALFUNCTION #2

SHOW TRANSPARENCY: FIGURE 54

NOTE: CUSTOMER COMPLAINS OF LACK OF COOLING

1. LOW SIDE GAUGE READING TOO LOW
2. HIGH SIDE GAUGE READING TOO LOW
3. DISCHARGE AIR FROM EVAPORATOR ONLY COOL
4. INSPECTION REVEALS HEAVY SWEAT OR FROST ON EXPANSION VALVE INLET

NOTE: CONDITION INDICATES EXPANSION VALVE RESTRICTING REFRIGERANT FLOW

J. HIGH SIDE RESTRICTION

SHOW TRANSPARENCY: FIGURE 55

NOTE: CUSTOMER COMPLAINS OF LITTLE COOLING FROM EVAPORATOR

1. LOW SIDE READING TOO LOW
2. HIGH SIDE READING TOO LOW
3. DISCHARGE AIR FROM EVAPORATOR ONLY SLIGHTLY COOL
4. COOL LINE, HEAVY SWEAT OR FROSTING ON RECEIVER OR LIQUID LINE

NOTE: CONDITION INDICATES A RESTRICTION IN THE RECEIVER OR LIQUID LINE

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

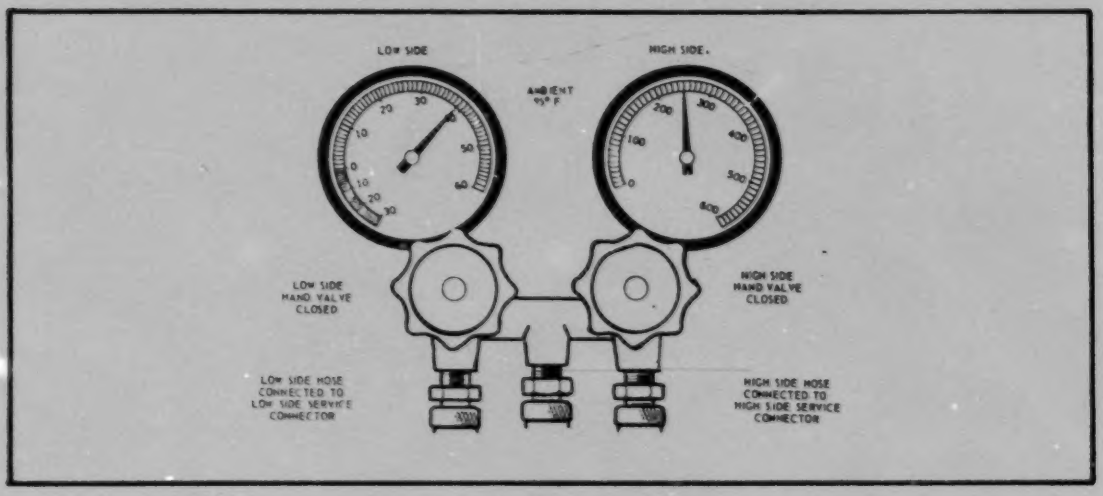
STUDENTS TO REVIEW AND DRILL ON LESSON. INSTRUCTOR WILL SHOW TRANSPARENCIES AND GIVE COMPLAINT OF THE CUSTOMER. THE STUDENT WILL ORALLY DIAGNOSE THE CONDITION AND COMPLAINT.

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

PICTORIAL RECALL TEST ON DIAGNOSING THE AIR CONDITIONING SYSTEM:

DIRECTIONS: OBSERVE THE FOLLOWING MANIFOLD GAUGE READINGS, RECORD FINDINGS AS TO PRESSURE IN PSI OR VACUUM IN INCHES; WHETHER THE READING IS HIGH, LOW, VERY LOW, OR NORMAL; EVAPORATOR DISCHARGE AIR IS WARM, HOT, COOL, OR COLD (NORMAL); SIGHT GLASS INSPECTION AS TO FREE OF BUBBLES, OCCASIONAL BUBBLES, BUBBLES STREAMING IN SIGHT GLASS, AND NO VISIBLE REFRIGERANT OR BUBBLES.

CONDITION #1: SYSTEM CONTAMINATED WITH AIR


LOW SIDE
HIGH SIDE
AMBIENT 95° F
LOW SIDE HAND VALVE CLOSED
HIGH SIDE HAND VALVE CLOSED
LOW SIDE HOSE CONNECTED TO LOW SIDE SERVICE CONNECTOR
HIGH SIDE HOSE CONNECTED TO HIGH SIDE SERVICE CONNECTOR

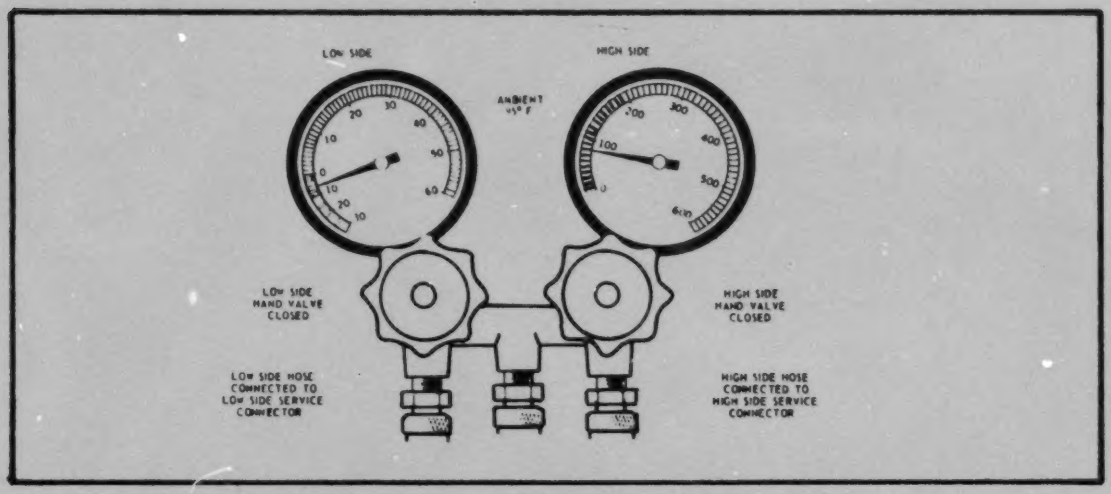
A. HIGH SIDE:
   1. RECORDED GAUGE READING: _____
   2. READING IS: HIGH _____ LOW _____
      VERY LOW _____ NORMAL _____

B. LOW SIDE:
   1. RECORDED GAUGE READING: _____
   2. READING IS: HIGH _____ LOW _____
      VERY LOW _____ NORMAL _____

C. EVAPORATOR DISCHARGE AIR:
   HOT _____ WARM _____
   COOL _____ COLD _____

D. SIGHT GLASS INSPECTION:
   FREE OF BUBBLES _____
   OCCASIONAL BUBBLES _____
   STREAMING BUBBLES _____
   NO VISIBLE REFRIGERANT _____

CONDITION #2: LACK OF REFRIGERANT CHARGE


LOW SIDE
HIGH SIDE
AMBIENT
LOW SIDE HAND VALVE CLOSED
HIGH SIDE HAND VALVE CLOSED
LOW SIDE HOSE CONNECTED TO LOW SIDE SERVICE CONNECTOR
HIGH SIDE HOSE CONNECTED TO HIGH SIDE SERVICE CONNECTOR

A. HIGH SIDE:
   1. RECORDED GAUGE READING: _____
   2. READING IS:

HIGH _____ LOW _____
VERY LOW _____ NORMAL _____

B. LOW SIDE:
   1. RECORDED GAUGE READING: _____
   2. READING IS:

HIGH _____ LOW _____
VERY LOW _____ NORMAL _____

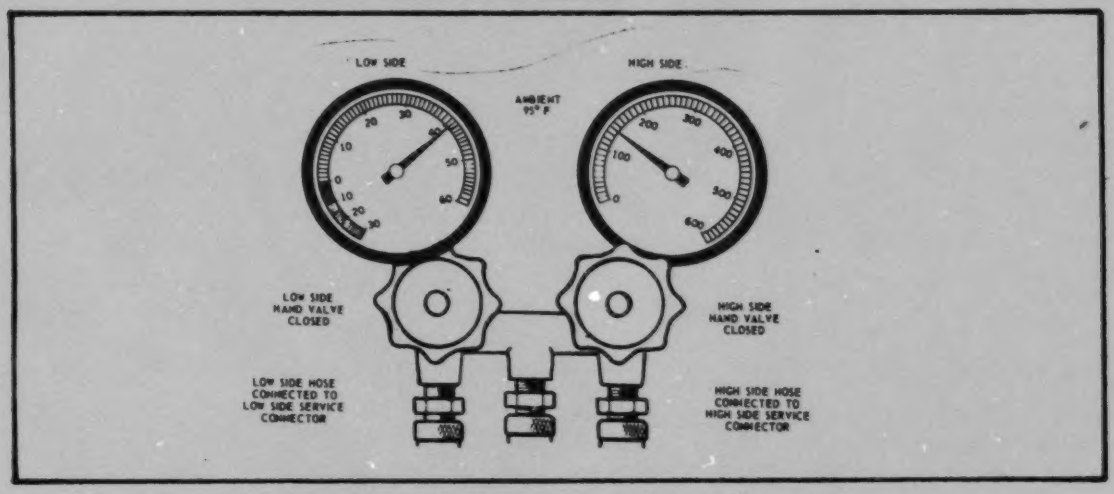
C. EVAPORATOR DISCHARGE AIR:

HOT _____ WARM _____
COOL _____ COLD _____

D. SIGHT GLASS INSPECTION:

FREE OF BUBBLES _____
OCCASIONAL BUBBLES _____
STREAMING BUBBLES _____
NO VISIBLE REFRIGERANT _____

CONDITION #3: COMPRESSOR MALFUNCTION


LOW SIDE
HIGH SIDE
AMBIENT 95° F
LOW SIDE HAND VALVE CLOSED
HIGH SIDE HAND VALVE CLOSED
LOW SIDE HOSE CONNECTED TO LOW SIDE SERVICE CONNECTOR
HIGH SIDE HOSE CONNECTED TO HIGH SIDE SERVICE CONNECTOR

A. HIGH SIDE:
   1. RECORDED GAUGE READING: _____
   2. READING IS:

HIGH _____ LOW _____

VERY LOW _____ NORMAL _____

B. LOW SIDE:
   1. RECORDED GAUGE READING: _____
   2. READING IS:

HIGH _____ LOW _____

VERY LOW _____ NORMAL _____

C. EVAPORATOR DISCHARGE AIR:

HOT _____ WARM _____

COOL _____ COLD _____

D. SIGHT GLASS INSPECTION:

FREE OF BUBBLES _____

OCCASIONAL BUBBLES _____

STREAMING BUBBLES _____

NO VISIBLE REFRIGERANT _____

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

A DIAGNOSTIC TEST OF THE AIR CONDITIONING SYSTEM CAN BE PERFORMED QUICKLY AND ACCURATELY BY CHECKING THE OPERATING EFFICIENCY OF THE SYSTEM. THIS TEST IS PERFORMED BY CONNECTING THE MANIFOLD GAUGE SET TO THE SYSTEM AND TAKING A READING OF THE LOW AND HIGH SIDE OF THE SYSTEM. THE NORMAL PRESSURE READING FOR THE LOW SIDE IS BETWEEN 7-30 PSI, AND FOR THE HIGH SIDE BETWEEN 185-205 PSI, WHEN THE AMBIENT TEMPERATURE IS 95°F.

BY TAKING AN ACCURATE READING WITH THE GAUGE, RECORDING THE DISCHARGED AIR TEMPERATURE AND COMPARING IT TO THE PERFORMANCE CHART, AND OBSERVING THE SIGHT GLASS FOR REFRIGERANT FLOW, AN ACCURATE DIAGNOSIS OF THE SYSTEM CAN BE PERFORMED.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA
AUTOMOTIVE MECHANICS, CH. 43
FUNDAMENTALS OF SERVICE AIR CONDITIONING

THE NEXT LESSON IS: IX-B-1(I), "PREPARATION FOR SERVICING THE REFRIGERATION SYSTEM"

INSTRUCTOR'S PLAN IX-A-3(S)
MANIPULATIVE LESSON

TASK:	LEAK DETECTING AND SYSTEM DIAGNOSIS
AIM:	STUDENT WILL BE ABLE TO SELECT LEAK DETECTING DEVICE, TEST REFRIGERATION SYSTEM FOR LEAKS, AND THE STUDENT WILL MAKE THOSE CORRECTIVE MEASURES NECESSARY TO PREVENT LINE SYSTEM LEAKS
TOOLS AND EQUIPMENT:	MANIFOLD AND GAUGE SET, HALIDE LEAK DETECTOR, REQUIRED TOOLS AND WRENCHES, SAFETY GOGGLES, THERMOMETER, AND FENDER COVERS
MATERIALS:	CLEAN RAGS
TEACHING AIDS:	IX-A-2 JOB AND TASK SHEETS AND PRESSURE-TEMPERATURE CHART
REFERENCES:	AUTOMOTIVE ENCYCLOPEDIA, PP. AUTO SERVICE AND REPAIR, PP. 33-12 TO 33-13 FUNDAMENTALS OF SERVICE AIR CONDITIONING, PP. 37-38 AUTOMOTIVE SERVICE MANUALS
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST HAVE COMPLETED ALL REQUIRED READING ASSIGNMENTS, HAVE STUDIED LESSON IX-A-6(I), "SERVICE EQUIPMENT", AND COMPLETED X-A-1 TASKS
CHECKING STANDARDS:	1. CORRECT SELECTION AND USE OF TOOLS AND EQUIPMENT 2. PROPER SETUP AND CARE OF MANIFOLD GAUGE SET 3. CORRECT USE OF LEAK DETECTOR 4. POSITIVE ATTITUDE TOWARD JOB AND A DISPLAY OF SAFE WORK HABITS 5. DISPLAY OF PRIDE IN WORK AND RESPECT FOR OWNER'S VEHICLE

I. PREPARATION (OF THE LEARNER - MOTIVATION)

MANY EXPENSIVE AIR CONDITIONING PROBLEMS ARE DUE TO LOSS OF REFRIGERANT THROUGH EITHER INTERNAL OR EXTERNAL LEAKS. THE DETECTION OF THESE LEAKS NOT ONLY CAN PREVENT MAJOR OVERHAULS, BUT ARE NECESSARY FOR DIAGNOSING THE SYSTEM FOR OTHER PROBLEMS THAT MAY BE A RESULT OF THE LEAK. IN THIS LESSON WE WILL PERFORM A LEAK DETECTING TEST USING THE HALIDE TORCH LEAK DETECTOR. WE WILL CONFINE OUR TEST TO THIS METHOD SINCE THE HALIDE TORCH IS THE MOST COMMON METHOD USED, AND THE PROCEDURE IN USING THE ELECTRONIC LEAK DETECTOR IS ESSENTIALLY THE SAME.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY
1. DEMONSTRATE	1. PERFORM ALL TASKS 2. MAKE ALL KEY POINTS CLEAR AND PRECISE 3. EMPHASIZE SAFETY PRECAUTIONS 4. ASK QUESTIONS AND REVIEW STEPS 5. WEAR SAFETY GOGGLES
2. PREPARE VEHICLE	1. PLACE VEHICLE IN WORK BAY NOTE: PROTECT SEAT COVERS WHEN MOVING VEHICLE 2. SET PARKING BRAKE 3. SET TRANSMISSION IN NEUTRAL OR PARK 4. OPEN HOOD 5. COVER FENDERS 6. PLACE FAN IN FRONT OF VEHICLE NOTE: EXTRA AIR FLOW FROM FAN WILL PREVENT ENGINE FROM OVER HEATING WHILE MAKING TEST
3. INSTALL MANIFOLD GAUGE SET	1. REMOVE SERVICE VALVE AND PORT PROTECTOR CAPS NOTE: USE CORRECT WRENCH TO PREVENT DAMAGE TO CAPS CAUTION: REMOVE SERVICE PORT CAP SLOWLY TO INSURE AGAINST REFRIGERANT LEAKING PAST SERVICE VALVE 2. CONNECT LOW SIDE MANIFOLD GAUGE TO SUCTION SIDE OF COMPRESSOR 3. CONNECT HIGH SIDE MANIFOLD GAUGE TO DISCHARGE SIDE OF COMPRESSOR NOTE: CONNECTIONS SHOULD BE FINGER TIGHT AND MANIFOLD GAUGE SHUT-OFF VALVES IN CLOSED POSITION
4. PURGE SERVICE HOSES	1. TURN SUCTION SIDE SERVICE VALVE STEM (IF SO EQUIPPED) THREE TURNS CLOCKWISE 2. TURN DISCHARGE SIDE SERVICE VALVE STEM (IF SO EQUIPPED) THREE TURNS CLOCKWISE NOTE: USE SERVICE VALVE WRENCH 3. OPEN LOW SIDE VALVE ON MANIFOLD

	GAUGE FOR A FEW SECONDS TO PURGE AIR FROM HOSE, THEN CLOSE 4. PURGE HIGH SIDE VALVE THE SAME AS THE LOW SIDE NOTE: PLACE END OF CENTER MANIFOLD HOSE ON CLEAN RAG
5. PREPARE FOR OPERATIONAL TEST	1. START ENGINE AND ADJUST ENGINE SPEED TO 1200 RPM 2. TURN AIR CONDITIONER SWITCHES ON 3. SET CONTROLS FOR MAXIMUM COOLING 4. SET BLOWER MOTOR SPEED SWITCH TO "HIGH" POSITION 5. ALLOW ENGINE TO WARM UP IF NOT AT OPERATING TEMPERATURE NOTE: ALLOW SYSTEM TO RUN FOR ABOUT 5 MINUTES TO ALLOW REFRIGERANT IN SYSTEM TO STABILIZE
6. PREPARE FOR PERFORMANCE TEST	1. TURN FAN IN FRONT OF RADIATOR ON TO ASSIST RAM AIR FLOW 2. INSERT THERMOMETER IN AIR CONDITIONING DUCT CLOSEST TO THE EVAPORATOR CORE 3. SET BLOWER SWITCH ON "LOW" POSITION
7. CHECK SYSTEM FOR FULL CHARGE	1. READ LOW PRESSURE GAUGE NOTE: IF READING IS NOT WITHIN SPECIFIED 20-30 PSIG RANGE, SYSTEM WILL NOT OPERATE TO STANDARDS 2. READ HIGH SIDE GAUGE NOTE: IF READING IS NOT WITHIN 160-220 PSIG RANGE, SYSTEM WILL NOT OPERATE TO STANDARDS 3. READ DISCHARGE AIR TEMPERATURE ON THERMOMETER NOTE: HUMIDITY WILL AFFECT DISCHARGE AIR TEMPERATURE. READINGS SHOULD BE WITHIN 35°F TO 45°F CAUTION: CERTAIN SYSTEM MALFUNCTIONS WILL CAUSE HIGH SIDE COMPONENTS TO BECOME SUPERHEATED TO THE POINT THAT SERIOUS BURNS CAN RESULT WHEN NOT HANDLED WITH CARE 4. INSPECT HIGH AND LOW SIDE OF SYSTEM FOR EVEN TEMPERATURE

NOTE: LOW SIDE LINES AND COMPONENTS SHOULD BE COOL TO TOUCH
NOTE: HIGH SIDE LINES AND COMPONENTS SHOULD BE WARM TO TOUCH

5. CHECK SIGHT GLASS FOR BUBBLES OR "MILKY" FLOW OF REFRIGERANT
   NOTE: SIGHT GLASS SHOULD BE CLEAR
6. SHUT OFF FAN AND ENGINE

8. TEST SYSTEM FOR LEAKS

1. HOLD LEAK DETECTOR TORCH IN UPRIGHT POSITION TO LIGHT
   NOTE: DIRECT TORCH AWAY FROM BODY
2. OPEN VALVE AND LIGHT ESCAPING GAS
   CAUTION: DO NOT LIGHT OR OPERATE TORCH IN ANY PLACE WHERE EXPLOSIVE GASES, DUST, OR VAPORS ARE PRESENT
3. ADJUST VALVE TO LOW FLAME THAT WILL NOT BLOW ITSELF OUT
4. PREHEAT UNTIL COPPER ELEMENT TURNS CHERRY RED
5. ADJUST FLAME UNTIL FLAME TIP IS EVEN OR SLIGHTLY BELOW CENTER OF ELEMENT
   CAUTION: TOO HIGH FLAME WILL BURN OUT THE ELEMENT
6. MOVE END OF SAMPLING HOSE UNDER HOSES, JOINTS, SEALS, AND ANY POSSIBLE PLACE FOR A LEAK TO OCCUR
   CAUTION: DO NOT BREATHE FUMES PRODUCED BY REFRIGERANT GAS
7. OBSERVE COLOR CHANGE OF FLAME
   a. PALE BLUE - NO REFRIGERANT LEAK
   b. YELLOWISH-GREEN - SMALL REFRIGERANT LEAK
   c. BLUE-MEDIUM REFRIGERANT LEAK
   d. PURPLE - LARGE REFRIGERANT LEAK
8. REPAIR SYSTEM AS NECESSARY IF LEAKS ARE LOCATED
   NOTE: TIGHTEN TUBE FITTINGS AND RETEST
9. CHECK SENSITIVITY OF REACTION PLATE

		NOTE: PASS SAMPLING HOSE OVER EMPTY CAN. FLAME SHOULD REACT VIOLENTLY NOTE: THIS TESTS THE ACCURACY OF THE TEST NOTE: IF NO COLOR CHANGE, REPLACE REACTION PLATE
		10. CLOSE LEAK DETECTOR TORCH VALVE
		11. SECURE AND STORE LEAK DETECTOR IN PROPER PLACE
9.	SECURE MANIFOLD GAUGE SET	1. REMOVE MANIFOLD GAUGE HOSE CONNECTORS FROM COMPRESSOR SERVICE VALVE PORTS CAUTION: WEAR SAFETY GOGGLES. WRAP HOSE END WITH RAG WHEN REMOVING FROM PORT
		2. INSTALL ALL PROTECTOR CAPS ON VALVES AND PORTS
		3. REPLACE MANIFOLD SET TO PROPER STORAGE PLACE
10.	SECURE WORK STATION	1. REMOVE FENDER COVERS AND STORE
		2. PARK VEHICLE IN DESIGNATED AREA
		3. REMOVE SEAT COVERS
		4. RETURN ALL TOOLS AND EQUIPMENT TO STORAGE AREA

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. HAVE STUDENTS REPEAT STEPS AND KEY POINTS AS THEY PERFORM TASKS.

2. OBSERVE AND RETEACH AS REQUIRED.

3. CHECK STUDENTS ON CHECKING STANDARDS.

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

STUDENT TO PERFORM TASK ON THEIR OWN.

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT EACH STEP IN THE LESSON.
2. REEMPHASIZE THE KEY POINTS.
3. REPEAT DIFFERENT READINGS OR MALFUNCTIONS THAT ARE DETECTABLE BY THE MANIFOLD GAUGE READING OR LEAK DETECTOR TEST.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, PP.
AUTO SERVICE AND REPAIR, PP. 33-12 TO 33-13
FUNDAMENTALS OF SERVICE AIR CONDITIONING, PP. 37-38
AUTOMOTIVE SERVICE MANUALS

THE NEXT LESSON IS: IX-B-1(S), "SERVICE AIR CONDITIONING SYSTEM"

110

JOB SHEET IX-A-3(J)
IN
AUTOMOTIVE AIR CONDITIONING

JOB:	LEAK DETECTING AND SYSTEM DIAGNOSIS
MATERIALS:	CLEAN RAGS
TOOLS AND EQUIPMENT:	MANIFOLD AND GAUGE SET, HALIDE LEAK DETECTOR, SERVICE VALVE WRENCH, TUBING WRENCH SET, SAFETY GOGGLES, THERMOMETER, DRIP PAN, SEAT AND FENDER COVERS, AND SAFETY GOGGLES
GENERAL INSTRUCTIONS:	BEFORE PERFORMING THIS JOB, IT IS ADVISABLE TO HAVE READ THE REQUIRED REFERENCE MATERIAL RELATED TO THIS JOB. A GENERAL UNDERSTANDING OF THE THEORY AND INTERPRETATION OF THE TEST INDICATIONS IS ESSENTIAL. EYE PROTECTION MUST BE WORN AT ALL TIMES WHEN SERVICING THE AIR CONDITIONER UNIT, AS REFRIGERANT 12 IS ODORLESS, COLORLESS, AND NONTOXIC, EXCEPT WHEN IN CONTACT WITH OPEN FLAME IT FORMS A DEADLY GAS. ALL SAFETY PRECAUTIONS SHOULD BE OBSERVED WHEN HANDLING REFRIGERANT, AND IN USING THE HALIDE LEAK DETECTOR.
PROCEDURES AND/OR TASKS:	IX-A-2(TS) INSTALL MANIFOLD GAUGE SET IX-A-2a(TS) PERFORM OPERATIONAL TEST IX-A-2b(TS) PERFORM LEAK TEST
CHECK POINT:	1. SELECTION OF CORRECT TEST EQUIPMENT 2. PROPER HOOKUP OF MANIFOLD GAUGE SET 3. CORRECT READING AND INTERPRETATIONS OF TEST 4. CORRECT USE OF HALIDE LEAK DETECTOR

TASK: INSTALL MANIFOLD GAUGE

JOB: LEAK DETECTING AND SYSTEM DIAGNOSIS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, SEAT AND FENDER COVER, MANIFOLD GAUGE SET WITH HOSES, SERVICE VALVE TOOL, HAND TOOLS, AND SAFETY GOGGLES

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. PLACE VEHICLE IN WORK BAY NOTE: PROTECT SEAT COVERS WHEN MOVING VEHICLE 2. SET PARKING BRAKE 3. SET TRANSMISSION IN NEUTRAL OR PARK 4. OPEN HOOD 5. COVER FENDERS 6. PLACE FAN IN FRONT OF VEHICLE NOTE: POSITION FOR BEST AIR FLOW TO RADIATOR NOTE: EXTRA AIR FLOW WILL PREVENT ENGINE FROM OVERHEATING WHILE MAKING TEST
2. REMOVE SERVICE VALVE AND PORT PROTECTION CAPS	1. USE SERVICE VALVE WRENCH 2. REMOVE PORT CAPS SLOWLY NOTE: CHECK FOR PRESENCE OF OIL AS CAP IS REMOVED
3. CONNECT GAUGE HOSES	1. CONNECT LOW SIDE MANIFOLD GAUGE HOSE TO SUCTION SIDE PORT OF COMPRESSOR 2. CONNECT HIGH SIDE MANIFOLD GAUGE TO DISCHARGE SIDE OF COMPRESSOR NOTE: CONNECTIONS SHOULD BE FINGER TIGHT TO PREVENT DAMAGE TO HOSE CONNECTOR SEAL 3. CLOSE MANIFOLD GAUGE VALVES 4. POSITION GAUGE AND HOSES FOR SAFE USAGE WHILE ENGINE IS IN OPERATION
4. PURGE SERVICE HOSE	1. TURN SUCTION SIDE SERVICE VALVE STEM (IF SO EQUIPPED) THREE TURNS CLOCKWISE

STEPS	KEY POINTS
	2. TURN DISCHARGE SIDE SERVICE VALVE STEM (IF SO EQUIPPED) THREE TURNS CLOCKWISE NOTE: USE SERVICE VALVE WRENCH 3. PLACE MANIFOLD GAUGE CHARGING HOSE ON CLEAN RAG 4. BRIEFLY OPEN AND CLOSE SUCTION VALVE TO PURGE AIR FROM HOSE 5. PURGE DISCHARGE SIDE THE SAME AS THE SUCTION SIDE NOTE: ANY DIRT, MOISTURE, OR OIL THROUGH THE CHARGING HOSE WILL BE HELD BY THE CLEAN RAG AT THE HOSE END
5. CLEAN WORK STATION	REFER TO IX-A-1(TS)

TASK SHEET IX-A-3a(TS)

TASK: PERFORM OPERATIONAL TEST

JOB: LEAK DETECTING AND SYSTEM DIAGNOSIS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, SEAT AND FENDER COVERS, MANIFOLD GAUGE SET WITH HOSES, SERVICE VALVE TOOL, TUBING WRENCH, HAND TOOLS, AND SAFETY GOGGLES

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	REFER TO IX-A-3(TS)
2. INSTALL MANIFOLD GAUGE SET	REFER TO IX-A-3(TS)
3. PREPARE FOR OPERATIONAL TEST	1. START ENGINE AND ADJUST ENGINE SPEED TO 1200 RPM 2. ADJUST AIR CONDITIONER CONTROLS TO MAXIMUM COOL 3. SET BLOWER SWITCH TO "HIGH" POSITION 4. ALLOW ENGINE TO WARM UP IF NOT AT OPERATING TEMPERATURE NOTE: ABOUT 5 MINUTES TO PERMIT REFRIGERANT IN THE SYSTEM TO STABILIZE 5. TURN ON FLOOR FAN 6. ADJUST AIR FLOW TO FRONT OF AUTO RADIATOR
4. TEST SYSTEM PERFORMANCE	1. INSERT THERMOMETER INTO COLD AIR OUTLET NEAREST EVAPORATOR CORE 2. SET BLOWER MOTOR SWITCHES IN LOW OR MEDIUM POSITION 3. CHECK SIGHT GLASS FOR BUBBLES OR "MILKY" CONDITION NOTE: IF LOW REFRIGERANT CHARGE IS INDICATED BY MILKY FLOW OR BUBBLES IN SIGHT GLASS (SHOULD BE CLEAR), THE SYSTEM WILL NOT CHECK OR OPERATE TO SPECIFICATIONS 4. READ LOW PRESSURE GAUGE NOTE: READING MUST BE WITHIN SPEC-

STEPS	KEY POINTS
	IFIED 20-30 PSIG RANGE, OR SYSTEM WILL NOT OPERATE TO STANDARDS
	5. READ HIGH PRESSURE GAUGE NOTE: READING MUST BE WITHIN 160-220 PSIG RANGE, OR SYSTEM WILL NOT OPERATE TO STANDARDS CAUTION: CERTAIN SYSTEM MALFUNCTIONS WILL CAUSE HIGH SIDE COMPONENTS TO BECOME SUPERHEATED TO THE POINT THAT SERIOUS BURNS CAN RESULT WHEN NOT HANDLED WITH CARE NOTE: DISCHARGE AIR TEMPERATURE WILL VARY DUE TO HUMIDITY. REFER TO "PERFORMANCE TEMPERATURE CHART" FOR VEHICLE BEING SERVICED AND CHECKING PROCEDURE
	6. INSPECT HIGH AND LOW SIDE OF SYSTEM FOR EVEN TEMPERATURES NOTE: SYSTEM OPERATING AT PEAK PERFORMANCE WILL HAVE CLEAR SIGHT GLASS, LOW SIDE COMPONENTS COOL TO TOUCH, AND HIGH SIDE COMPONENTS WARM TO THE TOUCH. ANY FREEZE OR EXCESSIVE HOT SPOTS INDICATE SYSTEM MALFUNCTION
	7. RETURN ENGINE TO NORMAL IDLE SPEED
	8. SHUT OFF ENGINE
	9. TURN OFF FLOOR FAN
5. REMOVE TEST EQUIPMENT	1. REMOVE THERMOMETERS
	2. DISCONNECT MANIFOLD GAUGE HOSES
	3. INSTALL PROTECTOR CAPS ON PORT OR SERVICE VALVES
	4. TIGHTEN SECURELY (USE CORRECT TOOL)
	5. DISCONNECT TACHOMETER (IF USED)
	6. CLOSE HOOD
6. CLEAN WORK STATION	AS PER IX-A-1(TS)

TASK: PERFORM LEAK TEST

JOB: LEAK DETECTING AND SYSTEM DIAGNOSIS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: CLEAN RAGS, SEAT AND FENDER COVERS, HALIDE LEAK DETECTOR, TORCH, TOOL SET WITH TUBING WRENCHES, AND SAFETY GOGGLES

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	REFER TO IX-A-1(TS)
2. VISUAL CHECK	1. CHECK OILY SPOTS WHICH WOULD INDICATE REFRIGERANT LEAKAGE AT COMPRESSOR SEAL AND ALL HOSE AND LINE CONNECTORS 2. CHECK EVAPORATOR AND CONDENSER FOR VISUAL SIGNS OF LEAKAGE 3. TIGHTEN ALL CONNECTIONS, USING CORRECT TOOL
3. LIGHT LEAK DETECTOR	1. HOLD HALIDE LEAK DETECTOR IN UPRIGHT POSITION TO LIGHT 2. POINT TORCH AWAY FROM BODY TO LIGHT 3. OPEN VALVE SLIGHTLY AND LIGHT ESCAPING GAS WITH MATCH 4. ADJUST FLAME TO BLUE COLOR BY OPENING OR CLOSING VALVE AS REQUIRED CAUTION: DO NOT LIGHT OR USE DETECTOR IN ANY PLACE WHERE DUST, VAPORS, OR EXPLOSIVE GASES MAY BE PRESENT
4. LEAK TEST LINES AND COMPRESSOR	1. MOVE END OF LEAK DETECTOR SAMPLING HOSE SLOWLY AROUND LINE CONNECTIONS AND COMPRESSOR FITTINGS WHERE LEAK MAY OCCUR NOTE: FLAME WILL CHANGE COLOR IF LEAK IS DETECTED. SMALL LEAK WILL PRODUCE A GREEN COLOR AND LARGE LEAK WILL PRODUCE A BRIGHT BLUE COLOR

STEPS	KEY POINTS
	2. MOVE END OF SAMPLING HOSE SLOWLY AROUND FRONT OF COMPRESSOR SEAL NOTE: REFRIGERANT IS HEAVIER THAN AIR AND LEAK MAY BE MORE EVIDENT AT LOWER PART OF SEAL AND CONNECTORS
	3. MOVE HOSE AROUND INLET AND OUTLET CONNECTIONS AT REAR OF COMPRESSOR
	4. NOTE ANY CHANGE IN COLOR OF FLAME AS SAMPLER HOSE IS MOVED IN LEAK TEST AREAS CAUTION: DO NOT BREATHE FUMES PRODUCED BY BURNING REFRIGERATION GAS WHICH COULD BECOME DANGEROUSLY TOXIC
5. LEAK TEST EVAPORATOR	1. MOVE END OF SAMPLING HOSE AROUND BOTTOM OF EVAPORATOR HOUSING AND INLET AND OUTLET LINES
	2. CAREFULLY CHECK AROUND EVAPORATOR HOUSING SEAL AT EVAPORATOR INLET TUBING NOTE: LEAK IS MOST LIKELY TO OCCUR AT THIS POINT
	3. USE SAME PROCEDURE TO TEST FOR LEAKS AT EXPANSION VALVE, SUCTION THROTTLING VALVE, AND OTHER CONTROL UNITS
6. LEAK TEST CONDENSER	1. MOVE END OF SAMPLING HOSE ALONG CONDENSER TUBING AND CONNECTORS OBSERVING DETECTOR FLAME COLOR NOTE: ALL CONNECTIONS MUST BE TIGHT TO PREVENT LEAKS
	2. MOVE END OF SAMPLING HOSE ALONG AND AROUND RECEIVER CONNECTIONS AND SIGHT GLASS NOTE: ANY LEAKAGE OF REFRIGERANT WILL CAUSE FLAME TO CHANGE COLOR
	3. TURN LEAK DETECTOR TORCH VALVE CLOCKWISE TO CLOSED POSITION
	4. STORE LEAK DETECTOR IN SAFE PLACE
7. CLEAN WORK STATION	AS PER IX-A-1(TS)

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

IX-B-1(I)

SUBJECT:	PREPARATION FOR SERVICING THE REFRIGERATION SYSTEM
AIM:	THE STUDENT WILL BE ABLE TO IDENTIFY THE EQUIPMENT USED IN THE SERVICE OF THE REFRIGERATION SYSTEM AND UNDERSTAND THE PROCEDURES REQUIRED FOR PREPARING THE SYSTEM FOR SERVICING OR COMPONENT REPAIR
TEACHING AIDS:	TRANSPARENCIES I. ED. IX-T, FIGURES 56-62
REFERENCES:	AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646 AUTOMOTIVE MECHANICS, CH. 43 AUTO SERVICE AND REPAIR, CH. 32 AUTOMOTIVE SERVICE MANUALS
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST HAVE STUDIED AND UNDERSTAND THAT INFORMATION COVERED IN PREVIOUS LESSONS ON SERVICE EQUIPMENT AND THE DIAGNOSIS OF THE REFRIGERATION SYSTEM.

I. PREPARATION (OF THE LEARNER - MOTIVATION)

AIR CONDITIONING SYSTEMS REQUIRE A NUMBER OF SPECIAL PREPARATORY PROCEDURES TO BE PERFORMED WHEN WORKING ON THE SYSTEM EITHER FOR THE PURPOSE OF SERVICING OR REPAIRING COMPONENT PARTS.

SHOULD THE SYSTEM BE CHARGED (UNDER PRESSURE) THE PRESSURE MUST BE RELIEVED IN ORDER TO DISASSEMBLE THE SYSTEM. THIS IS DONE BY DISCHARGING OR BLEEDING THE SYSTEM. IF THE SYSTEM IS NOT CHARGED, THEN IT MUST BE CHARGED AND LEAK TESTED TO DETERMINE THE PROBLEM BEFORE ANY OTHER WORK CAN BE DONE.

AFTER THE REPAIR WORK OR SERVICING IS COMPLETED, THE SYSTEM MUST BE EVACUATED TO REMOVE AIR OR MOISTURE IN THE SYSTEM CAUSED BY OPENING THE SYSTEM. THIS IS PERFORMED BY THE USE OF A CHARGING STATION OR VACUUM PUMP.

UPON COMPLETION OF EVACUATING THE SYSTEM, THE SYSTEM IS RECHARGED AND TESTED PRIOR TO BEING PUT BACK IN OPERATION.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. INTRODUCTION	1. WHEN SERVICING OR REPAIRING THE REFRIGERATION SYSTEM, SPECIAL PREPARATORY PROCEDURES ARE RE-

QUIRED TO BE PERFORMED
2. THESE SPECIAL PROCEDURES MUST BE FOLLOWED IN PROPER ORDER
3. OBSERVANCE OF ALL SAFETY PRECAUTIONS MUST BE FOLLOWED

B. CHECK SYSTEM FOR LEAKS
1. VISUAL INSPECTION
2. LEAK DETECTOR TEST
NOTE: REFER TO IX-A-6(I) "SERVICE EQUIPMENT"

C. BLEED OR DISCHARGE
1. SYSTEM MUST BE RELIEVED OF PRESSURE BEFORE LINES OR UNITS IN SYSTEM ARE DISCONNECTED

SHOW TRANSPARENCY: FIGURE 56

NOTE: REFERRED TO AS "PURGING" THE SYSTEM
NOTE: AN EXCEPTION TO THIS WOULD BE A COMPRESSOR THAT IS EQUIPPED WITH HAND OPERATED SERVICE VALVES
2. SHOW CORRECT SETUP OF MANIFOLD GAUGE SET
NOTE: MANIFOLD CENTER CONNECTION IS PLACED INTO THE SERVICE AREA EXHAUST OUTLET
NOTE: MANIFOLD VALVES MUST BE CLOSED BEFORE CONNECTING
CAUTION: BE SURE TO WEAR PROTECTIVE GOGGLES WHEN OPENING THE SYSTEM IN ANY WAY
3. STABILIZE SYSTEM
a. AIR CONDITIONING CONTROLS SET TO MAXIMUM COOLING
b. ENGINE R.P.M. 1500 - 1900 R.P.M. RANGE
c. OPERATION TIME 10 - 15 MINUTES
4. DISCHARGE SYSTEM WITH HAND SERVICE VALVES

SHOW TRANSPARENCY: FIGURE 62

NOTE: SHOW POSITION OF VALVES
a. HIGH PRESSURE VALVE CLOSED
b. LOW PRESSURE VALVE CLOSED
c. CRACK SERVICE VALVE ON HIGH SIDE
NOTE: REFRIGERANT SLOWLY ESCAPES THROUGH THE CENTER HOSE
CAUTION: RAPID DISCHARGING WILL DRAW COMPRESSOR OIL FROM THE SYSTEM

5. DISCHARGE SYSTEM WITH SCHRADER VALVE SERVICE FITTING
   a. BOTH VALVES MUST BE CLOSED
   b. CRACK MANIFOLD HIGH PRESSURE GAUGE TO ALLOW REFRIGERANT TO SLOWLY ESCAPE OUT CENTER CONNECTION HOSE
   c. CRACK LOW-PRESSURE GAUGE VALVE WHEN HIGH-PRESSURE GAUGE READS LESS THAN 100 PSI
   d. DISCHARGE UNTIL PRESSURE IS REMOVED

D. CHARGING SYSTEM

1. THE SYSTEM SHOULD BE CHARGED WITH REFRIGERANT ONLY AFTER IT HAS BEEN LEAK TESTED AND EVACUATED
   NOTE: IT IS IMPORTANT TO ADD ONLY THE SPECIFIED QUANTITY OF REFRIGERANT

SHOW TRANSPARENCY: FIGURE 58

2. MAY BE PERFORMED WITH:
   a. CHARGING STATION
   NOTE: CHARGING CYLINDER HOLDS BETWEEN 2 1/4 TO 4 LBS. OF REFRIGERANT
   NOTE: SHOW AND DISCUSS PORTABLE CHARGING STATION

SHOW TRANSPARENCY: FIGURES 59

   b. CHARGING SYSTEM - WEIGHING METHOD
   NOTE: SHOW AND DISCUSS SYSTEM
   NOTE: REFRIGERANT TANK IS PLACED IN WARM PAIL OF WATER AND BOTH ARE SET ON AN ACCURATE SCALE
   CAUTION: WATER TEMPERATURE MUST NOT EXCEED 125° F
   NOTE: REFRIGERANT MAY BE OBTAINED BY LIQUID OR GAS FORM

SHOW TRANSPARENCY: FIGURE 60

   a. CHARGING SYSTEM - ONE POUND CONTAINERS
   NOTE: REQUIRE DISPENSING VALVE INSTALLED

3. INDICATION OF FULL CHARGE WILL BE OBSERVED IN SIGHT GLASS BY CLEAR LIQUID
   NOTE: SOME SYSTEMS HAVE A HISSING SOUND IN THE EXPANSION VALVE UNTIL THE SYSTEM IS FULLY CHARGED

E. EVACUATE SYSTEM

1. REMOVES AIR AND MOISTURE UNTIL A VACUUM IS CREATED IN SYSTEM
2. NECESSARY BECAUSE AIR ENTERS THE OPENINGS BEFORE THEY CAN BE CAPPED WHEN SERVICING

SHOW TRANSPARENCIES: FIGURES 57 AND 58

3. MAY BE PERFORMED BY USE OF:
   a. VACUUM PUMP
   b. CHARGING STATION

   NOTE: CHARGING STATIONS ARE WIDELY USED IN GARAGES DUE TO COMPLETE HOOKUP AND EASE OF MOVING UNIT TO JOB
4. SYSTEM MUST BE FREE OF LEAKS AND DISCHARGED PRIOR TO EVACUATION
5. REQUIRES PULLING A VACUUM OF 26-28 INCHES

   NOTE: A VACUUM PUMP IN GOOD CONDITION WILL DRAW A VACUUM OF 28 INCHES AT SEA LEVEL

   NOTE: SUBSTRACT ONE INCH OF VACUUM FOR EVERY 1,000 FEET OF ELEVATION
6. PUMP DOWN SHOULD CONTINUE FOR 10 TO 15 MINUTES AFTER GAUGE READS 26 TO 28 INCHES OF VACUUM
7. SYSTEM SHOULD HOLD VACUUM WITH NO MORE THAN 2 INCHES DROP IN FIVE MINUTES AFTER THE PUMP HAS BEEN STOPPED AND THE VALVE IN VACUUM LINE SHUT OFF

F. ISOLATE COMPRESSOR FROM SYSTEM

1. ON SYSTEMS HAVING BOTH HIGH SIDE AND LOW SIDE SERVICE VALVES, THE COMPRESSOR MAY BE ISOLATED AND REFRIGERANT RETAINED IN THE SYSTEM WHILE SERVICE WORK IS BEING PERFORMED ON THE COMPRESSOR

SHOW TRANSPARENCY: FIGURE 61

2. STABILIZE SYSTEM AT SPECIFIED R.P.M. (a5-1900 R.P.M. RANGE)
3. COMPLETE ISOLATION OF COMPRESSOR BY:
   a. SLOWLY CLOSING LOW SIDE SERVICE VALVE UNTIL GAUGE READS 0 PSI
   b. SHUT OFF VALVE
   c. COMPLETELY CLOSE LOW SIDE SERVICE VALVE

d. CLOSE HIGH SIDE SERVICE VALVE
e. REFRIGERANT IS BLED FROM COMPRESSOR BY CRACKING LOW SIDE HAND MANIFOLD UNTIL BOTH GAUGES READ 0 PSI

NOTE: BLEED REFRIGERANT SLOWLY TO PREVENT PULLING OIL FROM COMPRESSOR

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

1. WHAT PROCEDURE MUST BE PERFORMED BEFORE AN OPERABLE SYSTEM IS DISCONNECTED FOR SERVICE OR REPAIR?

ANSWER: BEFORE DISCONNECTING A SYSTEM TO SERVICE OR REPAIR, THE SYSTEM MUST FIRST BE DISCHARGED OR BLED TO RELEASE THE PRESSURE.

2. WHAT IS THE RESULT OF BLEEDING THE SYSTEM TOO FAST?

ANSWER: TOO RAPID BLEEDING OF THE SYSTEM WILL DRAW OUT REFRIGERANT OIL FROM THE COMPRESSOR AND SYSTEM.

3. WHY SHOULD THE SYSTEM BE EVACUATED PRIOR TO PLACING BACK IN SERVICE?

ANSWER: THE SYSTEM SHOULD BE EVACUATED IN ORDER TO REMOVE AIR AND MOISTURE WHICH WILL CONTAMINATE THE SYSTEM AND CORRODE ITS WORKING PARTS.

4. BEFORE CHARGING A SYSTEM WITH REFRIGERANT, WHAT TWO PROCEDURES MUST BE CARRIED OUT?

ANSWER: BEFORE CHARGING THE SYSTEM, A LEAK TEST AND SYSTEM EVACUATION MUST BE CARRIED OUT.

5. IN ORDER FOR A COMPRESSOR TO BE ISOLATED FROM THE SYSTEM WHILE IT IS BEING SERVICED REQUIRES THE COMPRESSOR TO HAVE WHAT COMPONENT OPTIONS?

ANSWER: TO BE ISOLATED FROM THE SYSTEM BEING SERVICED REQUIRES THE COMPRESSOR TO HAVE A HIGH AND A LOW SIDE SERVICE VALVE.

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

SIMPLE RECALL

1. WHEN HEATING A REFRIGERANT TANK, THE WATER TEMPERATURE SHOULD NOT EXCEED ____ F. 125°

2. THE SYSTEM SHOULD BE CHARGED WITH A SPECIFIC AMOUNT, MEASURED BY _____, OF REFRIGERANT. — WEIGHT

3. TO PROPERLY EVACUATE THE SYSTEM, THE SYSTEM MUST BE SUBJECTED TO A VACUUM OF AROUND _____ INCHES. — 28

4. THE SYSTEM MAY BE EVACUATED BY USING A VACUUM PUMP ATTACHED TO THE SYSTEM OR WITH A _____. — CHARGING STATION

5. THE SYSTEM SHOULD HOLD VACUUM WITH NO MORE THAN _____ INCHES DROP IN FIVE MINUTES IF WORKING PROPERLY. — 2

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

PRIOR TO SERVICING OR REPAIRING THE AIR CONDITIONING SYSTEM, THERE ARE SPECIAL PREPARATIONAL PROCEDURES THAT MUST BE PERFORMED IN ORDER TO PROPERLY AND SAFELY WORK ON THE SYSTEM.

THESE PREPARATIONAL PROCEDURES MUST BE TAKEN IN A SEQUENTIAL ORDER AND CONSIST OF CHECKING THE SYSTEM FOR LEAKS AND DISCHARGING (PURGING) THE SYSTEM. UPON COMPLETION OF SERVICING OR MAKING COMPONENT PART REPAIRS, THE SYSTEM MUST BE EVACUATED, RECHARGED, AND RECHECKED FOR LEAKS BEFORE BEING PUT BACK INTO OPERATION.

BECAUSE OF THE SAFETY HAZARDS INVOLVED IN EACH ONE OF THE PROCEDURES, SAFETY PRECAUTIONS MUST BE OBSERVED AT ALL TIMES TO PROVIDE FOR THE SAFETY OF THE STUDENT AND PROTECTION AND CARE OF THE EQUIPMENT.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646
AUTOMOTIVE MECHANICS, CH. 43
AUTO SERVICE AND REPAIR, CH. 32
AUTOMOTIVE SERVICE MANUALS

THE NEXT LESSON IS: IX-B-3(I), "AIR CONDITIONING AUTOMATIC CLIMATE CONTROL SYSTEM"

INSTRUCTOR'S PLAN IX-B-1(S)
MANIPULATIVE LESSON

TASK:	SERVICE AIR CONDITIONING SYSTEM
AIM:	STUDENT WILL BE ABLE TO DISCHARGE, EVACUATE, CHARGE, AND CHECK OIL LEVEL OF AN AIR CONDITIONING SYSTEM.
TOOLS AND EQUIPMENT:	MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, OIL DIPSTICK
MATERIALS:	RAGS, R-12 REFRIGERANT, REFRIGERATION OIL
TEACHING AIDS:	COMPLETE REFRIGERANT SYSTEM AND CHARTS
REFERENCES:	BUICK CHASSIS SERVICE MANUAL AUTO SERVICE AND REPAIR, STOCKEL, CH. 32 AUTOMOTIVE MECHANICS, CROUSE, CH. 43 AUTOMOTIVE ENCYCLOPEDIA, GOODHEART-WILLCOX, PP. 643-644
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST BE FAMILIAR WITH AIR CONDITIONING NOMENCLATURE. THE STUDENT MUST HAVE HAD PRIOR KNOWLEDGE OF MANIFOLD GAGE HOOKUP.
CHECKING STANDARDS:	1. PROPER MANIFOLD GAGE HOOKUP 2. PROPER CHARGING AND DISCHARGING METHODS 3. POSITIVE ATTITUDE TOWARD WORK ACCOMPLISHMENT

I. PREPARATION (OF THE LEARNER - MOTIVATION)

A LARGE PERCENTAGE OF CARS TODAY HAVE AIR CONDITIONING SYSTEMS. MANY OF THE "SHADE TREE" MECHANICS OF YESTERYEAR ARE NOT FAMILIAR WITH HOW TO SERVICE AIR CONDITIONING SYSTEMS. IN THIS LESSON WE WILL LEARN HOW TO DISCHARGE, EVACUATE, AND RECHARGE AN AIR CONDITIONING SYSTEM. WITH THIS INFORMATION YOU MAY KNOW MORE ABOUT THE AIR CONDITIONING SYSTEM THAN AN EXPERIENCED MECHANIC. HOWEVER, IT WILL REQUIRE CLOSE ATTENTION AND A CONSTANT REALIZATION OF THE DANGER INVOLVED.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. PREPARE SYSTEM	1. HOOK UP MANIFOLD GAGE SET. REFER TO IX-A-3(S)

CAUTION: WEAR SAFETY GOGGLES

2. DISCONNECT SERVICE HOSE ADAPTER
3. PLACE END OF SERVICE HOSE IN CLEAN RAG

CAUTION: PROVIDE ADEQUATE VENTILATION DURING DISCHARGING OPERATION. DO NOT DISCHARGE NEAR OPEN FLAME, AS PHOSGENE GAS, A TOXIC GAS, WILL RESULT

2. DISCHARGE AIR CONDITIONING SYSTEM

1. CLOSE BOTH MANIFOLD VALVES
2. OPEN BOTH SERVICE VALVES (WHEN USED) SLOWLY
3. OPEN BOTH MANIFOLD VALVES SLOWLY

NOTE: RAPID DISCHARGING WILL DRAW OIL FROM SYSTEM. IF OIL IS DRAWN OUT, THE RAG WILL SHOW IT

4. DISCHARGE R-12 UNTIL BOTH GAGES INDICATE ZERO
5. CLOSE MANIFOLD VALVES
6. DISCONNECT MANIFOLD GAGE SET AND STORE IN DESIGNATED AREA

NOTE: IF REPAIR OF AIR CONDITIONING IS REQUIRED, SYSTEM MAY NOW BE OPENED

CAUTION: BE SURE TO CAP ALL OPENINGS TO PREVENT ENTRY OF FOREIGN MATTER

3. PREPARE TO EVACUATE

1. HOOK UP MANIFOLD GAGE SET. REFER TO IX-A-3(S)
2. BOTH MANIFOLD GAGE VALVES SHOULD BE CLOSED
3. ATTACH CENTER HOSE TO VACUUM PUMP

NOTE: SERVICE VALVES ON AIR CONDITIONER SHOULD BE IN CRACKED OPEN POSITION (IF USED)

4. EVACUATE SYSTEM

1. START VACUUM PUMP
2. SLOWLY OPEN BOTH MANIFOLD GAGE VALVES. THIS WILL PREVENT OIL FROM BEING DRAWN OUT OF THE PUMP
3. RUN VACUUM PUMP UNTIL COMPOUND GAGE (LOW SIDE) READS 28" HG.

NOTE: SUBSTRACT 1" HG. FOR EVERY

	1000 FEET OF ELEVATION. AT 5000 FEET ELEVATION, ONLY 23" TO 24" OF VACUUM CAN BE OBTAINED
	4. AFTER OBTAINING 28" OF VACUUM, RUN VACUUM PUMP AN ADDITIONAL 10 TO 15 MINUTES NOTE: IF VACUUM CANNOT BE PULLED TO THE SPECIFIED READING, IT INDICATES A LEAK IN THE SYSTEM, GAGE CONNECTIONS, OR DEFECTIVE VACUUM PUMP. THIS MALFUNCTION MUST BE CORRECTED BEFORE PROCEEDING TO NEXT STEP
	5. CLOSE BOTH MANIFOLD VALVES
	6. SHUT OFF VACUUM PUMP
	7. DISCONNECT CENTER MANIFOLD HOSE
	8. OBSERVE COMPOUND GAGE, AS VACUUM READING SHOULD BE CONSTANT NOTE: IF GAGE READING DROPS, A LEAK IS PRESENT AND MUST BE REPAIRED BEFORE PROCEEDING FURTHER NOTE: THE COMPLETE EVACUATING PROCESS MUST BE REPEATED AFTER REPAIRING LEAK
5. PREPARE AIR CONDITION SYSTEM TO CHARGE	1. RECHECK MANIFOLD GAGE HOOKUP
	2. CLOSE BOTH MANIFOLD GAGE VALVES
	3. CHECK TO SEE THAT COMPRESSOR SERVICE VALVES ARE IN THE CRACKED POSITION (IF USED)
6. PURGE HOSE	1. ATTACH REFRIGERANT CAN TO ADAPTER AND SECURE LOCKING NUT
	2. CONNECT REFRIGERANT CAN AND ADAPTER TO CENTER MANIFOLD OUTLET
	3. PIERCE REFRIGERANT CAN CAUTION: WEAR SAFETY GOGGLES
	4. WITH CAN PIERCED, OPEN TOP VALVE, AND FILL CENTER HOSE WITH R-12
	5. LOOSEN CENTER HOSE AT MANIFOLD GAGE SET UNTIL A HISSING NOISE IS HEARD
	6. TIGHTEN HOSE CONNECTION NOTE: THE SYSTEM IS NOW PURGED AND READY FOR CHARGING

7.	CHARGE SYSTEM	1. OPEN HIGH PRESSURE GAGE VALVE TO ALLOW R-12 TO FLOW INTO AIR CONDITIONING SYSTEM NOTE: MOST AIR CONDITIONING SYSTEMS WILL HOLD BETWEEN 2 AND 4 POUNDS OF R-12 NOTE: CHECK SERVICE MANUALS FOR EXACT AMOUNT OF R-12 CHARGE TO AVOID OVERCHARGING 2. TURN OFF VALVE WHEN R-12 STOPS FLOWING THROUGH HIGH PRESSURE VALVE 3. START ENGINE AND SET TO FAST IDLE 4. ENGAGE CLUTCH ON AIR CONDITIONER COMPRESSOR 5. SET CONTROLS TO MAXIMUM COLD WITH BLOWER SET ON HIGH SPEED 6. OPEN LOW PRESSURE GAGE VALVE, R-12 WILL BE DRAWN IN THROUGH SUCTION SIDE OF COMPRESSOR 7. WHEN SPECIFIED AMOUNT OF R-12 HAS ENTERED SYSTEM, TURN OFF R-12 SOURCE NOTE: ON SYSTEMS WHERE THE R-12 CAPACITY IS NOT KNOWN, ADD R-12 UNTIL SIGHT GLASS CLEARS, THEN ADD AN ADDITIONAL 1/4 POUND
8.	DISCONNECT MANIFOLD GAGE SET	1. REFER TO IX-A-3(S)
9.	CHECK SYSTEM FOR LEAKS	1. REFER TO IX-A-3(S)
10.	PREPARE SYSTEM TO CHECK COMPRESSOR OIL LEVEL (YORK, TECUMSEH, AIR TEMP.)	NOTE: IT IS NOT NECESSARY TO CHECK OIL LEVEL UNLESS THERE IS EVIDENCE OF A MAJOR LOSS OF OIL SUCH AS A BROKEN LINE, SERIOUS LEAK, OR COLLISION
	A. ISOLATE THE COMPRESSOR	1. ONLY SYSTEMS THAT HAVE SERVICE VALVES ON THE COMPRESSOR CAN UTILIZE THE FOLLOWING PROCEDURE CAUTION: WEAR SAFETY GOGGLES 2. CONNECT MANIFOLD GAGE SET AS PER IX-A-3(S)

3. LET AIR CONDITIONING SYSTEM RUN FOR 10 MINUTES
   NOTE: CLOSE BOTH MANIFOLD GAGE VALVES
4. COMPLETELY CLOSE (FRONT SEAT) BOTH SERVICE VALVES
5. OPEN LOW SIDE MANIFOLD VALVE TO RELEASE R-12. CLOSE MANIFOLD VALVE
6. OPEN HIGH SIDE MANIFOLD VALVE TO RELEASE R-12. CLOSE MANIFOLD VALVE
7. COMPRESSOR IS NOW ISOLATED FROM THE REST OF THE AIR CONDITIONING SYSTEM
   NOTE: THE ENTIRE AIR CONDITIONING SYSTEM DOES NOT HAVE TO BE DISCHARGED IN ORDER TO CHECK OIL LEVEL IF THE COMPRESSOR HAS SERVICE VALVES

B. DISCHARGE R-12 FROM ENTIRE SYSTEM

1. LET AIR CONDITIONING SYSTEM RUN FOR 10 MINUTES
2. DISCHARGE R-12 AS PER STEP 2 IN THIS LESSON

11. CHECK OIL LEVEL

1. REMOVE OIL PLUG FROM COMPRESSOR BODY
2. USE PROPER DIPSTICK TO CHECK OIL LEVEL
3. COMPARE WITH CHART TO CHECK PROPER OIL LEVEL
4. FILL WITH REFRIGERATION OIL AS NECESSARY
5. REPLACE OIL PLUG

12. PURGE AIR FROM COMPRESSOR (WITH SERVICE VALVES)

1. HOOK UP MANIFOLD GAGE SET. CLOSE VALVES
2. OPEN HIGH SIDE MANIFOLD VALVE
3. CRACK LOWSIDE COMPRESSOR SERVICE VALVE FROM FRONT SEAT POSITION
   NOTE: CAN ADAPTER MUST BE REMOVED
   NOTE: LOW SIDE REFRIGERANT WILL FORCE AIR OUT OF COMPRESSOR THROUGH HIGH SIDE HOSE

4. AFTER A FEW SECONDS, CLOSE HIGH SIDE MANIFOLD VALVE
   NOTE: COMPRESSOR IS NOW PURGED
   NOTE: ON SYSTEMS THAT WERE COMPLETELY DISCHARGED, EVACUATE, CHARGE AND LEAK TEST SYSTEM AS NECESSARY

13. CHECK OIL LEVEL ON GENERAL MOTORS TYPE COMPRESSOR (6 CYLINDER)

NOTE: IT IS NOT RECOMMENDED TO CHECK OIL LEVEL UNLESS THERE IS EVIDENCE OF A MAJOR LOSS OF OIL

1. HOOK-UP MANIFOLD GAGE SET AS PER IX-A-3(S)
2. RUN AIR CONDITION SYSTEM FOR 10 MINUTES
3. DISCHARGE SYSTEM AS PER STEP 2 IN THIS LESSON
   CAUTION: WEAR SAFETY GOGGLES
4. REMOVE COMPRESSOR FROM VEHICLE
5. REMOVE DRAIN PLUG
   NOTE: MAKE NOTE OF THE AMOUNT OF OIL DRAINED FROM COMPRESSOR AND THEN DISCARD IT
   NOTE: IF OIL DRAINED FROM THE COMPRESSOR IS LESS THAN 4 OUNCES, ADD 6 OUNCES OF NEW OIL TO THE COMPRESSOR
   NOTE: IF 4 TO 6 OUNCES OF OIL DRAINED FROM THE COMPRESSOR, REPLACE WITH EQUAL AMOUNT
   NOTE: IF MORE THAN 6 OUNCES OF OIL DRAINED FROM THE COMPRESSOR, REPLACE WITH ONLY 6 OUNCES
   NOTE: OIL CAN BE ADDED TO THE COMPRESSOR BY POURING OIL IN THE SUCTION PORT AND TURNING COMPRESSOR CLUTCH AT THE SAME TIME
   CAUTION: DO NOT OVER FILL. THE COMPLETE SYSTEM ONLY HOLDS 10 OUNCES OF 525 VISCOSITY OIL
6. REINSTALL COMPRESSOR ON VEHICLE
7. EVACUATE, CHARGE AND LEAK TEST AIR CONDITION SYSTEM AS COVERED EARLIER IN THE ASSIGNMENT
   CAUTION: THE AIR CONDITIONER COM-

PRESSOR IS NOT TO BE OPERATED WITH SERVICE VALVES IN THE CLOSED OR FRONT SEAT POSITION AS SEVERE DAMAGE TO THE COMPRESSOR MAY RESULT. VALVES MUST BE IN THE BACK-SEATED POSITION FOR CONTINOUS OPERATION OF THE COMPRESSOR

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS SHOULD GIVE PROCEDURES INVOLVED IN DISCHARGING, EVACUATING, AND CHARGING AN AIR CONDITIONING SYSTEM.
2. HAVE STUDENTS REPEAT STEPS AS THEY PERFORM TASKS.
3. ANSWER ANY QUESTIONS STUDENTS MIGHT HAVE.

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

STUDENTS TO BE PUT ON THEIR OWN FOR PERFORMANCE TEST.

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. REPEAT BRIEFLY THE STEPS INVOLVED IN THIS LESSON.
2. EMPHASIZE SAFETY PRECAUTIONS.
3. EMPHASIZE IMPORTANCE OF GOOD WORK HABITS AND CLEANLINESS NECESSARY WHEN WORKING ON THE AIR CONDITIONING SYSTEM.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE ENCYCLOPEDIA, PP. 643-644
AUTOMOTIVE MECHANIC, CH. 43
AUTO SERVICE AND REPAIR, CH. 42
AUTOMOTIVE SERVICE MANUALS
AUTOMOTIVE AIR CONDITIONING MANUALS

THE NEXT LESSON IS: IX-B-2(S) "AIR CONDITIONING COMPRESSOR REPAIR"

JOB: SERVICE AIR CONDITIONING SYSTEM

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, REFRIGERANT 12, RAGS, OIL DIPSTICK, SPECIAL COMPRESSOR TOOLS

GENERAL INSTRUCTIONS: THIS JOB IS AN IMPORTANT PART OF REPAIRING THE AIR CONDITIONING SYSTEM. BEFORE BEGINNING THIS JOB THE STUDENT SHOULD REVIEW MANIFOLD GAGE HOOK-UP AND SAFETY PRECAUTIONS IN PREVIOUS LESSONS.

PROCEDURE AND/OR TASKS:

IX-B-1(TS)	DISCHARGE AIR CONDITIONING SYSTEM
IX-B-1a(TS)	EVACUATE AIR CONDITIONING SYSTEM
IX-B-1b(TS)	CHARGE AIR CONDITIONING SYSTEM
IX-B-1c(TS)	CHECK COMPRESSOR OIL (YORK, TECUMSEH, AIR TEMP)
IX-B-1d(TS)	CHECK COMPRESSOR OIL (GENERAL MOTORS TYPE)

CHECK POINT: HAVE INSTRUCTOR CHECK EACH PROCEDURE DURING PERFORMANCE OF TASK

TASK SHEET IX-B-1(TS)

TASK: DISCHARGE AIR CONDITIONING SYSTEM

JOB: SERVICE AIR CONDITIONING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, RAGS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE SYSTEM	1. HOOK UP MANIFOLD GAGE SET. REFER TO IX-A-3a(TS) CAUTION: WEAR SAFETY GOGGLES 2. DISCONNECT SERVICE HOSE ADAPTER 3. PLACE END OF SERVICE HOSE IN CLEAN RAG CAUTION: PROVIDE ADEQUATE VENTILATION DURING DISCHARGING OPERATION. DO NOT DISCHARGE NEAR OPEN FLAME AS PHOSGENE GAS, A TOXIC GAS, WILL RESULT
2. DISCHARGE AIR CONDITIONING SYSTEM	1. BOTH MANIFOLD GAGE VALVES SHOULD BE CLOSED 2. OPEN BOTH SERVICE VALVES SLOWLY (WHEN USED) 3. OPEN BOTH MANIFOLD GAGE VALVES SLOWLY NOTE: RAPID DISCHARGING WILL DRAW OIL FROM SYSTEM, IF OIL IS DRAWN OUT, THE RAG WILL SHOW IT 4. DISCHARGE R-12 UNITL BOTH GAGES READ ZERO 5. CLOSE MANIFOLD GAGE VALVES 6. DISCONNECT MANIFOLD GAGE SET AND STORE IN DESIGNATED AREA NOTE: IF REPAIR OF AIR CONDITIONING COMPONENTS IS NECESSARY, SYSTEM MAY NOW BE OPENED CAUTION: BE SURE TO CAP ALL OPENINGS TO PREVENT ENTRY OF FOREIGN MATTER

STEPS	KEY POINTS
3. CLEAN WORK STATION	1. REFER TO IX-A-1(TS)

TASK: EVACUATE AIR CONDITIONING SYSTEM

JOB: SERVICE AIR CONDITIONING SYSTEM

TRADE AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE TO EVACUATE	1. HOOK UP MANIFOLD GAGE SET. REFER TO IX-A-3a(TS) 2. CLOSE BOTH MANIFOLD GAGE VALVES 3. ATTACH CENTER MANIFOLD HOSE TO VACUUM PUMP 4. CHECK TO SEE THAT SERVICE VALVES ON AIR CONDITIONING SYSTEM ARE IN THE CRACKED POSITION (IF USED)
2. EVACUATE SYSTEM	1. START VACUUM PUMP 2. SLOWLY OPEN BOTH MANIFOLD GAGE VALVES NOTE: THIS WILL PREVENT OIL FROM BEING DRAWN OUT OF THE PUMP 3. LET VACUUM PUMP RUN UNTIL THE COMPOUND GAGE (LOW SIDE) READS APPROXIMATELY 28" HG. NOTE: SUBSTRACT 1" HG. FOR EVERY 1000 FEET OF ELEVATION. AT 500 FEET ELEVATION, ONLY 23" TO 24" OF VACUUM CAN BE OBTAINED 4. AFTER OBTAINING 28" OF VACUUM, RUN VACUUM PUMP AN ADDITIONAL 10 TO 15 MINUTES NOTE: IF VACUUM CANNOT BE PULLED TO THE SPECIFIED READING, IT INDICATES A LEAK IN THE SYSTEM, GAGE CONNECTIONS OR DEFECTIVE VACUUM PUMP. THIS MALFUNCTION MUST BE CORRECTED BEFORE PROCEEDING TO NEXT STEP 5. CLOSE BOTH MANIFOLD VALVES 6. SHUT OFF VACUUM PUMP

STEPS	KEY POINTS
	7. DISCONNECT CENTER MANIFOLD HOSE 8. OBSERVE COMPOUND GAGE (LOW SIDE). VACUUM READING SHOULD BE CONSTANT NOTE: IF GAGE READING DROPS, A LEAK IS PRESENT AND MUST BE CORRECTED BEFORE PROCEEDING FURTHER NOTE: THE COMPLETE EVACUATING PROCESS MUST BE REPEATED AFTER REPAIRING LEAK 9. RETURN VACUUM PUMP TO STORAGE AREA
3. CLEAN WORK STATION	1. REFER TO IX-A-1(TS)

TASK: CHARGE THE AIR CONDITIONING SYSTEM

JOB: SERVICE AIR CONDITIONING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, R-12, RAGS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE TO CHARGE AIR CONDITIONING SYSTEM	1. RECHECK MANIFOLD GAGE HOOKUP 2. CHECK BOTH MANIFOLD GAGE VALVES TO MAKE SURE THEY ARE CLOSED NOTE: IT SHOULD BE UNDERSTOOD THAT BEFORE RECHARGING A SYSTEM IT SHOULD BE EVACUATED 3. CHECK COMPRESSOR SERVICE VALVES TO SEE THAT THEY ARE IN A CRACKED POSITION (IF USED)
2. PURGE HOSE	1. ATTACH REFRIGERANT CAN TO ADAPTER AND SECURE LOCKING NUT 2. CONNECT REFRIGERANT CAN AND ADAPTER TO CENTER MANIFOLD OUTLET CAUTION: WEAR SAFETY GOGGLES 3. PIERCE CAN 4. WITH CAN PIERCED, OPEN TAP VALVE. THIS WILL FILL CENTER HOSE WITH R-12 5. LOOSEN CENTER HOSE AT MANIFOLD GAGE SET UNTIL A HISSING NOISE IS HEARD 6. TIGHTEN HOSE CONNECTION NOTE: THE SYSTEM IS NOW PURGED AND READY FOR CHARGING
3. CHARGE SYSTEM	1. SLOWLY OPEN HIGH PRESSURE GAGE VALVE TO ALLOW R-12 TO FLOW INTO AIR CONDITIONING SYSTEM NOTE: MOST AIR CONDITIONING SYSTEMS WILL HOLD BETWEEN 2 AND 4

STEPS	KEY POINTS
	POUNDS OF R-12. CHECK SERVICE MANUALS FOR EXACT AMOUNT OF R-12 CHARGE TO AVOID OVERCHARGING 2. TURN OFF VALVE WHEN R-12 STOPS FLOWING THROUGH HIGH PRESSURE VALVE 3. START ENGINE AND SET TO FAST IDLE 4. ENGAGE CLUTCH ON AIR CONDITIONING COMPRESSOR 5. SET CONTROLS TO MAXIMUM COLD WITH BLOWER SET ON HIGH SPEED 6. OPEN LOW PRESSURE GAGE, R-12 WILL BE DRAWN IN THROUGH SUCTION SIDE OF COMPRESSOR 7. WHEN SPECIFIED AMOUNT OF R-12 HAS ENTERED SYSTEM, TURN OFF R-12 SOURCE NOTE: ON SYSTEMS WHERE THE R-12 CAPACITY IS NOT KNOWN, ADD R-12 UNTIL SIGHT GLASS CLEARS, THEN ADD AN ADDITIONAL 1/4 POUND 8. AIR CONDITIONING SYSTEM SHOULD NOW BE FULLY CHARGED
4. DISCONNECT MANIFOLD GAGE SET	1. REFER TO IX-A-3b(TS)
5. CHECK SYSTEM FOR LEAKS	1. REFER TO IX-A-3b(TS)
6. CLEAN WORK STATION	1. REFER TO IX-A-1(TS)

TASK SHEET IX-B-1c(TS)

TASK: CHECK COMPRESSOR OIL (YORK, TECUMSEH AND AIR-TEMP)

JOB: SERVICE AIR CONDITIONING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, RAGS, OIL DIPSTICK, VACUUM PUMP, REFRIGERATION OIL

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE SYSTEM TO CHECK COMPRESSOR OIL	NOTE: IT IS NOT NECESSARY TO CHECK COMPRESSOR OIL UNLESS THERE IS EVIDENCE OF A MAJOR LOSS OF OIL SUCH AS A BROKEN LINE, SERIOUS LEAK, OR COLLISION
A. ISOLATE THE COMPRESSOR	NOTE: ONLY SYSTEMS THAT HAVE SERVICE VALVES ON THE COMPRESSOR CAN USE THE FOLLOWING PROCEDURE CAUTION: WEAR SAFETY GOGGLES 1. DISCONNECT MANIFOLD GAGE SET AS PER IX-A-3a(TS) 2. START CAR AND LET AIR CONDITIONING SYSTEM RUN FOR APPROXIMATELY 10 MINUTES. THIS WILL STABILIZE THE SYSTEM NOTE: BOTH MANIFOLD GAGE VALVES SHOULD BE CLOSED 3. COMPLETELY CLOSE (FRONT SEAT) BOTH SERVICE VALVES 4. OPEN LOW SIDE MANIFOLD VALVE TO RELEASE R-12, CLOSE MANIFOLD VALVE 5. OPEN HIGH SIDE MANIFOLD VALVE TO RELEASE R-12, CLOSE MANIFOLD NOTE: COMPRESSOR IS NOW ISOLATED FROM THE REST OF THE AIR CONDITIONING SYSTEM NOTE: THE ENTIRE AIR CONDITIONING SYSTEM DOES NOT NEED TO BE DISCHARGED IF THE COMPRESSOR HAS SERVICE VALVES

STEPS	KEY POINTS
B. DISCHARGE R-12 FROM ENTIRE SYSTEM	1. CONNECT MANIFOLD GAGE SET AS PER IX-A-3a(TS) CAUTION: WEAR SAFETY GOGGLES 2. LET AIR CONDITIONING SYSTEM RUN FOR APPROXIMATELY 10 MINUTES 3. DISCHARGE R-12 AS PER IX-B-1(TS)
2. CHECK OIL LEVEL	1. REMOVE OIL PLUG FROM COMPRESSOR BODY 2. USE PROPER DIPSTICK TO CHECK OIL LEVEL 3. COMPARE WITH OIL LEVEL CHART FOR PROPER LEVEL 4. FILL COMPRESSOR WITH REFRIGERANT OIL AS NECESSARY 5. REPLACE OIL PLUG
3. PURGE AIR FROM COMPRESSOR (WITH SERVICE VALVES)	1. HOOK-UP MANIFOLD GAGE SET AS PER IX-A-3a(TS) NOTE: MANIFOLD VALVES SHOULD BE CLOSED 2. OPEN HIGH SIDE MANIFOLD VALVE 3. CRACK LOW SIDE COMPRESSOR SERVICE VALVE FROM FRONT SEAT POSITION NOTE: LOW SIDE REFRIGERANT WILL FORCE AIR OUT OF COMPRESSOR THROUGH HIGH SIDE HOSE NOTE: REFRIGERANT CAN ADAPTER MUST BE REMOVED 4. CLOSE HIGH SIDE MANIFOLD VALVE AFTER A FEW SECONDS NOTE: COMPRESSOR IS NOW PURGED NOTE: ON SYSTEMS THAT WERE COMPLETELY DISCHARGED, EVACUATION AND CHARGING OF SYSTEM IS NECESSARY
4. EVACUATE R-12 SYSTEM	1. REFER TO IX-B-1a(TS)
5. CHARGE R-12 SYSTEM	1. REFER TO IX-B-1e(TS)
6. LEAK TEST R-12 SYSTEM	1. REFER TO IX-A-1c(TS)
7. CLEAN WORK STATION	1. REFER TO IX-A-1(TS)

TASK: CHECK COMPRESSOR OIL (GENERAL MOTORS TYPE)

JOB: SERVICE AIR CONDITIONING SYSTEM

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS, DRAIN PAN, SPECIAL COMPRESSOR TOOLS, R-12 AND REFRIGERATION OIL

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE SYSTEM	NOTE: IT IS NOT RECOMMENDED TO CHECK OIL LEVEL UNLESS THERE IS EVIDENCE OF A MAJOR LOSS OF OIL 1. HOOK UP MANIFOLD GAGE SET AS PER IX-A-3(TS) CAUTION: WEAR SAFETY GOGGLES 2. RUN AIR CONDITION SYSTEM FOR APPROXIMATELY 10 MINUTES 3. DISCHARGE SYSTEM AS PER IX-B-1(TS)
2. CHECK COMPRESSOR OIL	1. REMOVE COMPRESSOR FROM VEHICLE 2. REMOVE DRAIN PLUG NOTE: MAKE NOTE OF THE AMOUNT OF OIL DRAINED FROM THE COMPRESSOR 3. ADD OIL TO THE COMPRESSOR BY POURING OIL INTO THE SUCTION PORT AND TURNING COMPRESSOR CLUTCH AT THE SAME TIME CAUTION: DO NOT OVERFILL. THE COMPLETE SYSTEM HOLDS ONLY 10 OUNCES OF 525 VISCOSITY OIL NOTE: IF OIL DRAINED FROM COMPRESSOR IS LESS THAN 4 OUNCES, ADD 6 OUNCES OF NEW OIL TO THE COMPRESSOR NOTE: IF 4 TO 6 OUNCES OF OIL DRAINED FROM THE COMPRESSOR, REPLACE WITH EQUAL AMOUNT NOTE: IF MORE THAN 6 OUNCES OF OIL DRAINED FROM THE COMPRESSOR, REPLACE WITH ONLY 6 OUNCES

STEPS	KEY POINTS
	7. REINSTALL COMPRESSOR ON VEHICLE
3. EVACUATE R-12 SYSTEM	1. REFER TO IX-B-1a(TS)
4. CHARGE R-12 SYSTEM	1. REFER TO IX-B-1b(TS)
5. LEAK TEST R-12 SYSTEM	1. REFER TO IX-A-1c(TS)
6. CLEAN WORK STATION	1. REFER TO IX-A-1(TS)

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INSTRUCTOR'S PLAN IX-B-2(S)
MANIPULATIVE LESSON

TASK:	AIR CONDITIONING COMPRESSOR REPAIR
AIM:	STUDENT WILL BE ABLE TO REPAIR OR, IF NECESSARY, REPLACE COMPRESSOR IN AN AIR CONDITIONING SYSTEM.
TOOLS AND EQUIPMENT:	MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, SPECIAL COMPRESSOR TOOLS, PRESSURE TEST PLATE
MATERIALS:	RAGS, R-12 REFRIGERANT, REFRIGERANT OIL, SEAL KITS, GASKETS, VALVE PLATE KIT, BEARINGS
TEACHING AIDS:	COMPLETE REFRIGERANT SYSTEM
REFERENCES:	AUTOMOTIVE CHASSIS SERVICE MANUALS AUTO SERVICE AND REPAIR, STOCKEL, CH. 32 AUTOMOTIVE MECHANICS, CROUSE, CH. 43 AUTOMOTIVE ENCYCLOPEDIA, GOODHEART-WILLCOX, PP. 635-646
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST BE FAMILIAR WITH AIR CONDITIONING NOMENCLATURE. THE STUDENT MUST ALSO HAVE PRIOR KNOWLEDGE OF THE MANIFOLD GAGE HOOKUP AND SERVICING OF THE AIR CONDITIONING SYSTEM AND MUST HAVE SATISFACTORILY COMPLETED PREVIOUS LESSON.
CHECKING STANDARDS:	1. PROPER MANIFOLD GAGE HOOKUP 2. CONFORMANCE TO SAFETY PRECAUTIONS 3. PROPER SERVICING METHODS 4. ABILITY TO ISOLATE PROBLEMS 5. POSITIVE ATTITUDE TOWARD JOB AND WORK HABITS

I. PREPARATION (OF THE LEARNER - MOTIVATION)

ALL OF THE COMPONENTS OF AN AIR CONDITIONING SYSTEM ARE OF UTMOST IMPORTANCE. HOWEVER, IF WE WERE TO CHOOSE ONE COMPONENT AS BEING THE CENTER OR ORGINATOR OF ACTION, THE COMPRESSOR WOULD BE THE MOST IMPORTANT. IN THIS LESSON WE WILL LEARN TO MAKE MINOR REPAIRS TO THE AIR CONDITIONING COMPRESSOR.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. DEMONSTRATE	1. PERFORM ALL TASKS 2. ANSWER ALL QUESTIONS

3. MAKE KEY POINTS CLEAR AND PRECISE
4. EMPHASIZE SAFETY

2. PREPARE VEHICLE
1. POSITION VEHICLE IN STALL
2. SET PARKING BRAKE
3. DISCONNECT BATTERY GROUND

3. REPLACE COMPRESSOR SHAFT OIL SEAL (YORK TECUMSEH AND CHRYSLER AIR TEMP)
1. PREPARE FOR REPLACEMENT OF COMPRESSOR SHAFT OIL SEAL
NOTE: THE FOLLOWING OPERATION CAN USUALLY BE PERFORMED WITH COMPRESSOR ATTACHED TO THE VEHICLE. HOWEVER IF FAN OR RADIATOR PREVENTS REMOVAL OF CLUTCH AND PULLEY ASSEMBLY, REMOVE COMPRESSOR FROM VEHICLE
2. DISCHARGE SYSTEM - REFER TO IX-B-1(S)
NOTE: ON SOME MODELS IT IS POSSIBLE TO ISOLATE THE COMPRESSOR AND DISCHARGE ONLY THE R-12 IN THE COMPRESSOR WITHOUT DISCHARGING THE REST OF THE SYSTEM

A. ISOLATE COMPRESSOR
NOTE: ONLY SYSTEMS THAT HAVE SERVICE VALVES CAN UTILIZE THE FOLLOWING STEPS
1. CONNECT MANIFOLD GAGE SET - CLOSE VALVES
2. COMPLETELY CLOSE (FRONT SEAT) BOTH SERVICE VALVES
3. OPEN LOW SIDE MANIFOLD VALVE TO RELEASE R-12. CLOSE MANIFOLD VALVE
4. OPEN HIGH SIDE MANIFOLD VALVE TO RELEASE R-12. CLOSE MANIFOLD VALVE
NOTE: COMPRESSOR IS NOW ISOLATED AND CAN BE REMOVED FROM VEHICLE OR DISMANTLED STILL ATTACHED TO VEHICLE

B. REMOVE CLUTCH ASSEMBLY
1. REMOVE BELT FROM COMPRESSOR PULLEY
2. ENERGIZE CLUTCH
3. REMOVE BOLT FROM CENTER OF CLUTCH ASSEMBLY TO CRANKSHAFT

4. REMOVE CLUTCH AND PULLEY
   NOTE: IF CLUTCH IS A STATIONARY FIELD TYPE AND FIELDS ARE MOUNTED TO SEAL PLATE, REMOVE THE BOLTS HOLDING IT IN PLACE AND REMOVE FIELDS
   NOTE: IF ROTATING FIELDS AND BRUSHES ARE MOUNTED ON THE SEAL PLATE, REMOVE THE BRUSHES AND COIL HOUSING
   NOTE: TAKE CARE NOT TO BREAK THE SOFT CARBON BRUSHES
5. CLEAN AREA AROUND SEAL PLATE

C. REMOVE SEAL ASSEMBLY

1. REMOVE SCREWS HOLDING ON SEAL PLATE
   CAUTION: CLEANLINESS IS OF UTMOST IMPORTANCE
   NOTE: KEEP PARTS IN SEQUENTIAL ORDER TO FACILITATE REASSEMBLY
2. PRY OFF SEAL PLATE
   CAUTION: DO NOT DAMAGE MATING SURFACES
3. REMOVE SEAL NOSE ASSEMBLY FROM THE CRANKSHAFT
4. REMOVE GASKET MATERIAL FROM MATING SURFACE
   NOTE: CLEAN ENTIRE SEAL AREA
   CAUTION: BE CAREFUL NOT TO NICK OR MAR SURFACES

D. INSTALL SEAL ASSEMBLY

1. WOODRUFF KEY MUST BE REMOVED FROM CRANKSHAFT BEFORE INSTALLING NEW SEAL
2. CHECK CRANKSHAFT SURFACE AREA FOR DAMAGE
3. WASH SEAL IN REFRIGERATION OIL
4. COAT CRANKSHAFT WITH REFRIGERATION OIL
5. INSTALL NEW SEAL ASSEMBLY ON CRANKSHAFT
   NOTE: IF PARTS WERE PLACED IN SEQUENTIAL ORDER DURING DISASSEMBLY, REASSEMBLY WILL BE EASIER
6. INSTALL CARBON RING OUTWARD

	CAUTION: DO NOT TOUCH CARBON RING WITH FINGERS, AS ACID FROM FINGERS MAY HARM SEAL
	7. INSTALL SEAL PLATE AND RETAINER
	8. TORQUE TO SPECIFICATIONS
E. INSTALL CLUTCH ASSEMBLY	1. INSTALL FIELD AND BRUSH ASSEMBLY (IF USED)
	2. PLACE WOODRUFF KEY IN GROOVE OF CRANKSHAFT
	3. INSTALL PULLEY AND CLUTCH ASSEMBLY
	4. ENERGIZE CLUTCH
	5. TORQUE TO SPECIFICATIONS
	6. DE-ENERGIZE CLUTCH
	7. ROTATE COMPRESSOR CLUTCH SEVERAL TURNS TO SEAT SEAL
4. PURGE AIR FROM COMPRESSOR (WITH SERVICE VALVES)	1. HOOK UP MANIFOLD GAGE SET. CLOSE VALVES
	2. OPEN HIGH SIDE MANIFOLD VALVE
	3. CRACK LOW SIDE COMPRESSOR SERVICE VALVE FROM FRONT SEAT POSITION
	4. LOW SIDE REFRIGERANT WILL FORCE AIR OUT OF COMPRESSOR THROUGH HIGH SIDE HOSE. AFTER A FEW SECONDS CLOSE HIGH SIDE MANIFOLD VALVE
	5. COMPRESSOR IS NOW PURGED
	6. BACK SEAT BOTH SERVICE VALVES
	7. RECONNECT BATTERY GROUND
A. EVACUATE R-12 SYSTEM	1. REFER TO IX-B-1(S)
B. CHARGE R-12 SYSTEM	1. REFER TO IX-B-1(S)
C. LEAK TEST R-12 SYSTEM	1. REFER TO IX-A-3(S)
5. REPLACE COMPRESSOR SHAFT SEAL (GENERAL MOTORS TYPE, 6 CYLINDER)	1. DISCHARGE R-12 FROM COMPLETE AIR CONDITION SYSTEM NOTE: SERVICE VALVES ARE NOT USED ON THIS TYPE COMPRESSOR
	2. SOME COMPRESSORS WILL ALLOW SEAL REPLACEMENT WHILE INSTALLED ON VEHICLE, OTHERS WILL NOT

3. IF REMOVAL IS REQUIRED, SECURE COMPRESSOR IN HOLDING FIXTURE. POSITION DRAIN PAN TO CATCH OIL
NOTE: KEEP PARTS IN ORDER TO FACILITATE REASSEMBLY

A. SEAL REMOVAL

1. REMOVE FRONT SHAFT NUT
NOTE: KEEP HUB FROM TURNING BY USING A CLUTCH HUB HOLDING TOOL
2. REMOVE SNAP RING RETAINER INSIDE CLUTCH HUB
3. REMOVE SPACER UNDERNEATH SNAP RING
4. REMOVE CLUTCH FROM CRANKSHAFT WITH CLUTCH PULLER
5. REMOVE FELT ABSORBENT SLEEVE
6. REMOVE SHAFT SEAL SEAT RETAINING RING
NOTE: USE SHAFT SEAL SEAT REMOVING TOOL TO REMOVE SEAT
7. REMOVE SHAFT SEAL
8. REMOVE SEAL O-RING
9. CLEAN SEAL AREA THOROUGHLY
10. INSPECT FOR SCRATCHES ON MATING SURFACES

B. SEAL INSTALLATION

1. PLACE O-RING SEAL ON INSTALLER AND SLIDE O-RING INTO PLACE
2. PLACE SHAFT SEAL PROTECTOR OVER SHAFT
3. COAT SHAFT WITH REFRIGERANT OIL
4. USING SHAFT SEAL INSTALLING TOOL TO INSTALL SHAFT SEAL. ROTATE UNTIL "FLAT" OF SEAL FITS OVER "FLAT" ON SHAFT
5. INSTALL SHAFT SEAL SEAT WITH SEAT INSTALLER TOOL
NOTE: REMOVE SEAL PROTECTOR
6. INSTALL SEAL SEAT SNAP RING
NOTE: BEVELED EDGE OF SNAP RING MUST FACE OUTSIDE OF COMPRESSOR
7. INSTALL FELT ABSORBENT SLEEVE AND RETAINER

C. CLUTCH INSTALLATION

1. PLACE WOODRUFF KEY IN SHAFT KEYWAY

NOTE: ALLOW 3/16" TO STICK OUT END OF KEYWAY

2. START CLUTCH ON END OF SHAFT
   CAUTION: BE CAREFUL NOT TO PUSH KEY INTO SHAFT SEAL
3. PRESS CLUTCH INTO PLACE
   NOTE: CLEARANCE BETWEEN CLUTCH PLATE AND PULLEY DRIVE PLATE IS .030"
4. INSTALL SPACER AND SNAP RING
5. INSTALL SHAFT NUT
6. ROTATE COMPRESSOR CLUTCH SEVERAL TIMES TO SEAT SEAL
7. EVACUATE AND CHARGE AS PER IX-B-1 (S)
8. LEAK TEST AS PER IX-A-3(S)

6. REPLACE COMPRESSOR VALVE PLATE (YORK, TECUMSEH, AND AIR TEMP)

1. ALTHOUGH VALVE PLATE REPLACEMENT MAY VARY SLIGHTLY, THE FOLLOWING PROCEDURE WILL FOLLOW A GENERAL DIRECTION TO COVER ALL COMPRESSORS
2. AIR CONDITIONING SYSTEM WILL NEED TO BE DISCHARGED OR COMPRESSOR ISOLATED ACCORDING TO TYPE OF UNIT BEING REPAIRED

A. REMOVE VALVE PLATE

1. REMOVE SERVICE VALVES (IF USED)
2. REMOVE BOLTS HOLDING CYLINDER HEAD TO CRANKCASE BODY
   NOTE: TAPPING OR PRYING MAY BE NECESSARY BUT CAUTION SHOULD BE USED TO PREVENT DAMAGE TO COMPRESSOR
3. ON CHRYSLER AIR-TEMP, TWO CYLINDER HEADS ARE USED, OTHERS USE ONLY ONE CYLINDER HEAD
4. SEPARATE CYLINDER HEAD AND VALVE PLATE
   NOTE: DO NOT DISASSEMBLE VALVE PLATES. THEY ARE NOT SERVICED SEPARATELY
5. CAREFULLY SCRAPE GASKET MATERIAL FROM SURFACES
6. REPLACE NECESSARY PARTS

B. INSTALL VALVE PLATE
1. APPLY THIN COAT OF REFRIGERATION OIL ON ALL GASKETS AND SURFACES
2. ALIGN GASKETS ON CRANKCASE ASSEMBLY
3. PLACE VALVE PLATE IN POSITION
4. ALIGN GASKET ON TOP OF VALVE PLATE
5. PLACE CYLINDER HEAD IN POSITION
6. TORQUE TO SPECIFICATIONS
7. REPLACE SERVICE VALVES (IF USED)

C. EVACUATE R-12 SYSTEM
1. REFER TO IX-B-1(S)

D. CHARGE R-12 SYSTEM
1. REFER TO IX-B-1(S)

E. LEAK TEST R-12 SYSTEM
1. REFER TO IX-A-3(S)

7. REPLACE COMPRESSOR VALVE PLATES (GENERAL MOTORS TYPE, 6 CYLINDER)
1. ON THIS MODEL IT WILL BE NECESSARY TO REMOVE COMPRESSOR FROM VEHICLE
2. THIS WILL NECESSITATE THE REMOVAL OF R-12 FROM AIR CONDITIONING SYSTEM
3. REMOVE BELT AND DISCONNECT ATTACHING PARTS
4. SECURE IN HOLDING FIXTURE AND POSITION DRAIN PAN
5. DISASSEMBLE COMPRESSOR SHELL COMPLETELY

A. REMOVE COMPRESSOR PULLEY AND COIL

NOTE: KEEP PARTS IN SEQUENTIAL ORDER TO FACILITATE REASSEMBLY
1. REMOVE FRONT SEAL ASSEMBLY AS PER STEP 5 A IN THIS LESSON
2. REMOVE SNAP RING HOLDING PULLEY IN PLACE
3. REMOVE PULLEY WITH DESIGNATED PULLER
4. REMOVE SNAP RING HOLDING COIL IN PLACE

B. DISASSEMBLE COMPRESSOR
1. GENTLY SLIDE COIL OFF THE FRONT OF THE COMPRESSOR
2. REMOVE FOUR NUTS OFF OF REAR OF COMPRESSOR
3. REMOVE REAR HEAD AND O-RING

4. REMOVE OIL PUMP GEARS AND SUCTION SCREEN
5. GENTLY PRY UP DISCHARGE PLATE WITH TWO SCREW DRIVERS BENEATH REED RETAINERS
6. VERY CAREFULLY LIFT OFF REED PLATE
   CAUTION: COMPRESSOR PARTS ARE PRECISION MEASURED AND MUST BE HANDLED GENTLY
7. REMOVE OIL PICK-UP TUBE
8. REMOVE INTERNAL ASSEMBLY THROUGH REAR OPENING OF COMPRESSOR SHELL
   NOTE: IT MAY BE NECESSARY TO TAP ON FRONT HEAD WITH PLASTIC HAMMER TO REMOVE FROM SHELL. IF THE INTERNAL ASSEMBLY AND FRONT HEAD WILL NOT SEPARATE, REMOVE AS AN ASSEMBLY
9. SEPARATE FRONT HEAD AND INTERNAL ASSEMBLY. BE CAREFUL NOT TO DAMAGE REED AND DISCHARGE PLATES

C. CLEAN, INSPECT, AND REPLACE PARTS

1. CLEAN, INSPECT AND REPLACE ANY DAMAGED PARTS BEFORE STARTING THE REASSEMBLY PROCEDURE
   NOTE: IF BROKEN PARTS OR METAL PARTICLES ARE FOUND, REPLACE RECEIVER-DEHYDRATOR ASSEMBLY. THIS WILL BE COVERED IN A LATER LESSON

D. REASSEMBLE COMPRESSOR

1. INSTALL FRONT REED PLATE ON FRONT OF INTERNAL ASSEMBLY
   NOTE: ALIGN DOWEL PINS FOR PROPER INSTALLATION
2. PLACE DISCHARGE PLATE INTO POSITION AGAINST REED PLATE
   NOTE: FRONT DISCHARGE PLATE HAS THE LARGER CENTER HOLE. REED RETAINERS FACING OUT
3. GENEROUSLY LUBRICATE SEALING AREAS WITH 525 VISCOSITY COMPRESSOR OIL
4. ALIGN DOWEL PINS WITH HOLES IN FRONT HEAD AND GENTLY LOWER INTO

POSITION

5. INSTALL O-RING IN ANGLED GROOVE AT LOWER EDGE OF FRONT HEAD
6. LUBRICATE INSIDE SURFACES OF SHELL WITH OIL
   CAUTION: USE CARE WHEN SLIDING INTERNAL ASSEMBLY AND FRONT HEAD INTO SHELL SO AS NOT TO DISLODGE O-RING
7. SLIDE ASSEMBLY INTO SHELL AND ALIGN OIL SUMP WITH THE OIL PICK-UP TUBE HOLE
8. INSTALL NEW OIL RING IN OIL PICK-UP TUBE CAVITY AND INSERT OIL PICK-UP TUBE. ROTATE COMPRESSOR INTERNAL ASSEMBLY TO ALIGN WITH SHELL
9. INSTALL REAR REED PLATE AND DISCHARGE PLATE OVER DOWEL PINS (REED RETAINERS FACING OUT)
10. INSTALL OIL PUMP GEARS WITH IDENTIFICATION MARKS UP
11. INSERT SUCTION SCREEN IN REAR HEAD
12. INSTALL O-RING
13. LUBRICATE SEALING SURFACES
14. ALIGN REAR HEAD WITH DOWEL PINS AND INSTALL HEAD
    NOTE: MAKE CERTAIN THAT SUCTION SCREEN DOES NOT FALL OUT OF REAR HEAD
15. IF REAR HEAD DOES NOT ALIGN WITH DOWEL PINS, ROTATE FRONT HEAD SLIGHTLY UNTIL REAR HEAD DROPS OVER DOWELS
16. INSTALL NUTS AND TORQUE TO SPECIFICATIONS

E. INSTALL COIL AND PULLEY

1. INSTALL COIL AND SNAP RING
2. INSTALL PULLEY WITH PULLEY INSTALLATION TOOL
3. INSTALL SNAP RING
4. INSTALL FRONT SEAL AS PER STEP 5 B
5. INSTALL CLUTCH AS PER STEP 5 C
   CAUTION: WEAR SAFETY GOGGLES

8. INSTALL COMPRESSOR AND CONNECT LINES

NOTE: IF COMPRESSOR WAS REMOVED, REINSTALL AND CONNECT LINES

9.	SERVICE R-12 SYSTEM	1. EVACUATE R-12 SYSTEM 2. CHARGE R-12 SYSTEM 3. LEAK TEST R-12 SYSTEM
10.	SECURE WORK STATION	1. AS PER IX-A-1(S)

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO REPEAT STEPS AND KEY POINTS AS THEY PERFORM TASKS.
2. OBSERVE AND RETEACH AS NECESSARY.
3. STUDENTS WORK TO ACCOMPLISH CHECKING STANDARDS.

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

PUT STUDENTS ON THEIR OWN TO PERFORM TASKS.

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. BRIEFLY REPEAT STEPS IN STAGE II.
2. EMPHASIZE NOTES AND PRECAUTIONS IN STAGE II.
3. EMPHASIZE SAFETY PRECAUTIONS.

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE SERVICE MANUALS
AUTO SERVICE AND REPAIR, CH. 32
AUTOMOTIVE MECHANICS, CH. 43
AUTOMOTIVE ENCYCLOPEDIA, PP. 635-646

THE NEXT LESSON IS: IX-B-3(S) "REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS"

JOB: AIR CONDITIONING COMPRESSOR REPAIR

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, SPECIAL COMPRESSOR TOOLS, RAGS, R-12 REFRIGERANT, REFRIGERANT OIL, SEAL KITS, GASKETS, VALVE PLATE KITS, BEARINGS, PRESSURE TEST PLATE

GENERAL INSTRUCTIONS: COMPRESSORS ARE DELICATE PIECES OF EQUIPMENT AND MUST BE HANDLED WITH CARE. A THOROUGH UNDERSTANDING OF COMPRESSOR NOMENCLATURE IS ESSENTIAL BEFORE ATTEMPTING THE FOLLOWING TASKS.

PROCEDURE AND/OR TASKS:

IX-B-2(TS)	REPLACE COMPRESSOR SHAFT OIL SEAL (YORK, TECUMSEH, AND AIR-TEMP)
IX-B-2a(TS)	REPLACE COMPRESSOR SHAFT OIL SEAL (GENERAL MOTORS TYPE, 6 CYLINDER)
IX-B-2b(TS)	REPLACE COMPRESSOR VALVE PLATES (YORK, TECUMSEH, AND AIR-TEMP)
IX-B-2c(TS)	REPLACE COMPRESSOR VALVE PLATES (GENERAL MOTORS TYPE, 6 CYLINDER)

CHECK POINT: BEFORE INSTALLING COMPRESSOR ON VEHICLE, HAVE INSTRUCTOR CHECK WORK.

IX-B-2d(TS)	PRESSURE TEST COMPRESSOR (GENERAL MOTORS TYPE, 6 CYLINDER)
IX-B-2e(TS)	REPLACE PULLEY BEARING (YORK, TECUMSEH, AIR-TEMP, AND GENERAL MOTORS TYPE, 6 CYLINDER)

HAVE INSTRUCTOR INSPECT EACH PROCEDURE DURING PERFORMANCE OF TASK

TASK: REPLACE COMPRESSOR SHAFT OIL SEAL (YORK, TECUMSEH, AND AIR-TEMP)

JOB: AIR CONDITIONING COMPRESSOR REPAIR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS, R-12 REFRIGERANT, REFRIGERANT OIL, SEAL KIT

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN STALL 2. SET PARKING BRAKE 3. DISCONNECT GROUND BATTERY CABLE 4. UTILIZE FENDER COVERS NOTE: ON SOME MODELS IT IS POSSIBLE TO ISOLATE THE COMPRESSOR AND DISCHARGE ONLY THE R-12 IN THE COMPRESSOR WITHOUT DISCHARGING THE REST OF THE SYSTEM
2. DISCHARGE R-12	1. TO ISOLATE THE COMPRESSOR REFER TO IX-B-1c(TS) 2. TO DISCHARGE THE ENTIRE SYSTEM REFER TO IX-B-1(TS)
3. REMOVE CLUTCH ASSEMBLY	1. REMOVE BELT FROM COMPRESSOR PULLEY NOTE: IF FAN OR RADIATOR PREVENTS DISASSEMBLY, REMOVE COMPRESSOR FROM VEHICLE 2. ENERGIZE CLUTCH 3. REMOVE BOLT FROM CENTER OF CLUTCH ASSEMBLY TO CRANKSHAFT, USING 1/2" SOCKET 4. USE 5/8" NC BOLT TO REMOVE CLUTCH AND PULLEY 5. RE-ENERGIZE CLUTCH 6. IF A STATIONARY FIELD TYPE IS USED AND FIELD IS MOUNTED TO COMPRESSOR, REMOVE BOLTS AND REMOVE FIELD

STEPS	KEY POINTS
	7. IF ROTATING FIELDS AND BRUSHES ARE MOUNTED ON THE SEAL PLATE, REMOVE BRUSHES AND COIL HOUSING CAUTION: TAKE CARE NOT TO BREAK THE SOFT CARBON BRUSHES
	8. CLEAN AREA AROUND SEAL PLATE
4. REMOVE SEAL ASSEMBLY	1. REMOVE SCREWS HOLDING ON SEAL PLATE CAUTION: CLEANLINESS IS OF UTMOST IMPORTANCE NOTE: KEEP PARTS IN SEQUENTIAL ORDER TO FACILITATE REASSEMBLY
	2. PRY OFF SEAL PLATE. DO NOT DAMAGE MATING SURFACES
	3. REMOVE SEAL NOSE ASSEMBLY FROM THE CRANKCASE
	4. REMOVE GASKET MATERIAL FROM AND CLEAN ENTIRE SEAL AREA
5. INSTALL SEAL ASSEMBLY	1. REMOVE WOODRUFF KEY BEFORE INSTALLING NEW SEAL
	2. CHECK CRANKSHAFT SURFACE AREA FOR DAMAGE
	3. WASH NEW SEAL IN REFRIGERATION OIL
	4. COAT CRANKSHAFT WITH REFRIGERATION OIL
	5. INSTALL NEW SEAL ASSEMBLY ON CRANKSHAFT
	6. THE CARBON RING MUST FACE OUTWARD CAUTION: DO NOT TOUCH CARBON RING WITH FINGERS, ACID FROM FINGERS MAY HARM THE SEAL
	7. INSTALL SEAL PLATE AND RETAINERS
	8. TORQUE TO SPECIFICATIONS
6. INSTALL CLUTCH ASSEMBLY	1. INSTALL FIELD AND BRUSH ASSEMBLY (IF USED)
	2. PLACE WOODRUFF KEY IN CRANKSHAFT GROOVE
	3. INSTALL PULLEY AND CLUTCH ASSEMBLY
	4. ENERIZE CLUTCH
	5. TORQUE BOLT TO SPECIFICATIONS

STEPS	KEY POINTS
	6. ROTATE COMPRESSOR CLUTCH SEVERAL TURNS TO SEAT SEAL 7. DE-ENERGIZE CLUTCH 8. RECONNECT GROUND BATTERY CABLE
7. PURGE AIR FROM COMPRESSOR (WITH SERVICE VALVES)	1. REFER TO IX-B-1c(TS)
8. EVACUATE ENTIRE R-12 SYSTEM	1. REFER TO IX-B-1a(TS)
9. CHARGE ENTIRE R-12 SYSTEM	1. REFER TO IX-B-1b(TS)
10. LEAK TEST R-12 SYSTEM	1. REFER TO IX-A-3b(TS)
11. CLEAN WORK STATION	1. REFER TO IX-A-3(TS)

TASK: REPLACE COMPRESSOR SHAFT OIL SEAL (GENERAL MOTORS TYPE, 6 CYLINDER)

JOB: AIR CONDITIONING COMPRESSOR REPAIR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, SPECIAL COMPRESSOR TOOLS, RAGS, R-12, REFRIGERANT OIL, SEAL KIT

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN STALL 2. SET PARKING BRAKE 3. DISCONNECT GROUND BATTERY CABLE 4. UTILIZE FENDER COVERS
2. REMOVE CLUTCH	NOTE: IF FAN OR RADIATOR PREVENTS DISASSEMBLY, REMOVE COMPRESSOR FROM VEHICLE 1. DISCHARGE R-12 AS PER IX-B-1(TS) 2. IF REMOVAL OF COMPRESSOR IS REQUIRED, SECURE IN HOLDING FIXTURE. POSITION DRAIN PAN TO CATCH OIL NOTE: KEEP PARTS IN ORDER TO FACILIATE REASSEMBLY 3. REMOVE FRONT SHAFT NUT USING A THINWALL 9/16" SOCKET. KEEP CLUTCH FROM TURNING BY USING A CLUTCH HUB HOLDING TOOL 4. REMOVE SNAP RING RETAINER INSIDE CLUTCH HUB 5. REMOVE SPACER UNDERNEATH SNAP RING 6. USING A CLUTCH PULLER, REMOVE CLUTCH FROM CRANKSHAFT
3. REMOVE SEAL	1. REMOVE FELT ABSORBENT SLEEVE 2. REMOVE SHAFT SEAL SEAT RETAINING RING 3. USE SHAFT SEAL SEAT REMOVING TOOL TO REMOVE SEAT 4. USE SHAFT SEAL REMOVER TO REMOVE SEAL

STEPS	KEY POINTS
	5. WITH SMALL WIRE, REMOVE SEAT O-RING
	6. CLEAN SEAL AREA THOROUGHLY
	7. INSPECT FOR SCRATCHES ON MATING SURFACES
4. SEAL INSTALLATION	1. PLACE O-RING SEAL ON INSTALLER TOOL AND SLIDE O-RING INTO PLACE
	2. PLACE SHAFT SEAL PROTECTOR OVER SHAFT
	3. COAT SHAFT WITH REFRIGERANT OIL
	4. USE SHAFT SEAL INSTALLING TOOL TO INSTALL SHAFT SEAL. ROTATE UNTIL "FLAT" OF SEAL FITS OVER "FLAT" ON SHAFT
	5. INSTALL SHAFT SEAL SEAT WITH SEAT INSTALLER TOOL
	6. REMOVE SEAL PROTECTOR
	7. INSTALL SEAL SEAT SNAP RING NOTE: BEVELED EDGE OF SNAP RING MUST FACE TOWARD OUTSIDE OF COMPRESSOR
	8. INSTALL FELT ABSORBENT SLEEVE AND RETAINER
5. CLUTCH INSTALLATION	1. PLACE WOODRUFF KEY IN SHAFT KEYWAY. ALLOW 3/16" TO STICK OUT END OF KEYWAY
	2. START CLUTCH ON SHAFT, BEING CAREFUL NOT TO PUSH KEY INTO SHAFT SEAL
	3. USE CLUTCH INSTALLING TOOL TO PRESS CLUTCH INTO PLACE. CLEARANCE BETWEEN CLUTCH PLATE AND PULLEY DRIVE PLATE IS .030"
	4. INSTALL SPACER AND SNAP RING
	5. INSTALL NUT ON SHAFT, TORQUE, USE HUB HOLDING TOOL TO PREVENT CLUTCH FROM ROTATING
	6. ROTATE COMPRESSOR CLUTCH SEVERAL TURNS TO SEAT SEAL
	7. RECONNECT GROUND BATTERY CABLE
6. EVACUATE R-12 SYSTEM	1. REFER TO IX-B-1a(TS)
7. CHARGE R-12 SYSTEM	1. REFER TO IX-B-1b(TS)
8. LEAK TEST R-12 SYSTEM	1. REFER TO IX-A-3b(TS)
9. CLEAN WORK STATION	1. REFER TO IX-A-1(TS)

TASK: REPLACE COMPRESSOR VALVE PLATES (YORK, TECUMSEH, AND AIR-TEMP)

JOB: AIR CONDITIONING COMPRESSOR REPAIR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, FENDER COVERS, SERVICE VALVE WRENCH, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS, R-12, REFRIGERANT OIL, VALVE PLATE KITS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN STALL 2. SET PARKING BRAKE 3. DISCONNECT GROUND BATTERY CABLE 4. UTILIZE FENDER COVERS
2. DISCHARGE R-12	NOTE: ALTHOUGH VALVE PLATE REPLACEMENT MAY VARY SLIGHTLY, THE PROCEDURES WILL FOLLOW A GENERAL DIRECTION TO COVER ALL COMPRESSORS 1. AIR CONDITIONING SYSTEM WILL NEED TO BE DISCHARGED OR COMPRESSOR ISOLATED ACCORDING TO THE TYPE OF UNIT BEING REPAIRED 2. TO ISOLATE THE COMPRESSOR REFER TO IX-B-1c(TS) 3. TO DISCHARGE THE ENTIRE SYSTEM REFER TO IX-B-1(TS)
3. REMOVE VALVE PLATE	1. REMOVE SERVICE VALVES (IF USED) 2. REMOVE BOLTS HOLDING CYLINDER HEAD TO CRANKCASE BODY NOTE: TAPPING OR PRYING MAY BE NECESSARY TO REMOVE CYLINDER HEAD BUT CAUTION SHOULD BE USED TO PREVENT DAMAGE TO COMPRESSOR 3. AIR TEMP COMPRESSORS HAVE TWO CYLINDER HEADS 4. SEPARATE CYLINDER HEAD AND VALVE PLATE NOTE: DO NOT DISASSEMBLE VALVE

STEPS	KEY POINTS
	PLATES, THEY ARE NOT SERVICEABLE
	5. CAREFULLY SCRAPE GASKET MATERIAL FROM SURFACES
	6. INSPECT AND REPLACE NECESSARY PARTS
4. INSTALL VALVE PLATES	1. APPLY THIN COAT OF REFRIGERATION OIL ON ALL SURFACES AND GASKETS
	2. ALIGN GASKETS ON CRANKCASE ASSEMBLY
	3. PLACE VALVE PLATE IN POSITION
	4. ALIGN GASKET ON TOP OF VALVE PLATE
	5. PLACE CYLINDER HEAD INTO POSITION
	6. TORQUE TO SPECIFICATIONS
	7. REPLACE SERVICE VALVES (IF USED)
	8. PURGE COMPRESSOR AS PER IX-B-1c(TS)
	9. RECONNECT GROUND BATTERY CABLE
5. EVACUATE R-12 SYSTEM	1. EVACUATE SYSTEM IF NECESSARY AS PER IX-B-1a(TS)
6. CHARGE R-12 SYSTEM	1. RECHARGE SYSTEM IF NECESSARY AS PER IX-B-1b(TS)
7. LEAK TEST R-12 SYSTEM	1. REFER TO IX-A-3b(TS)
8. CLEAN WORK STATION	1. REFER TO IX-A-3(TS)

TASK: REPLACE COMPRESSOR VALVE PLATES (GENERAL MOTORS TYPE, 6 CYLINDER)

JOB: AIR CONDITIONING COMPRESSOR REPAIR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, SPECIAL COMPRESSOR TOOLS, RAGS, R-12, REFRIGERANT OIL, VALVE PLATES, SEAL KITS, DRAIN PAN

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN STALL 2. SET PARKING BRAKE 3. DISCONNECT GROUND BATTERY CABLE 4. UTILIZE FENDER COVERS
2. PREPARE COMPRESSOR FOR DISASSEMBLY	1. DISCHARGE R-12 SYSTEM - REFER TO IX-B-1(TS) 2. REMOVE COMPRESSOR FROM VEHICLE 3. SECURE IN HOLDING FIXTURE NOTE: THIS OPERATION WILL REQUIRE COMPLETE DISASSEMBLY OF COMPRESSOR SHELL 4. POSITION DRAIN PAN
3. DISASSEMBLE COMPRESSOR CLUTCH AND FRONT SEAL	NOTE: KEEP PARTS IN SEQUENTIAL ORDER TO FACILITATE REASSEMBLY 1. REMOVE CLUTCH AND FRONT SEAL AS PER IX-B-2a(TS) 2. REMOVE SNAP RING HOLDING PULLEY IN PLACE 3. REMOVE PULLEY WITH DESIGNATED PULLER 4. REMOVE COIL RETAINING SNAP RING, GENTLY SLIDE COIL OFF
4. DISASSEMBLE COMPRESSOR AND CLEAN	1. REMOVE FOUR BOLTS ON REAR OF COMPRESSOR 2. REMOVE REAR HEAD AND O-RING 3. REMOVE OIL PUMP GEARS AND SUCTION SCREEN 4. GENTLY PRY UP DISCHARGE PLATE

STEPS	KEY POINTS
	WITH TWO SCREWDRIVERS BENEATH REED RETAINERS
	5. CAREFULLY LIFT OFF REED PLATE CAUTION: COMPRESSOR PARTS ARE PRECISION MEASURED AND MUST BE HANDLED CAREFULLY
	6. REMOVE OIL PICKUP TUBE
	7. REMOVE INTERNAL ASSEMBLY THROUGH REAR OPENING OF COMPRESSOR SHELL NOTE: IT MAY BE NECESSARY TO TAP ON FRONT HEAD WITH PLASTIC HAMMER
	8. IF THE INTERNAL ASSEMBLY AND FRONT HEAD WILL NOT SEPARATE, REMOVE AS AN ASSEMBLY
	9. SEPARATE FRONT HEAD AND INTERNAL ASSEMBLY, BE CAREFUL NOT TO DAMAGE REED AND DISCHARGE PLATES
	10. CLEAN, INSPECT, AND REPLACE ANY DAMAGED PARTS BEFORE STARTING THE REASSEMBLY PROCEDURE
5. COMPRESSOR INTERNAL REASSEMBLY	1. INSTALL FRONT REED PLATE ON FRONT OF INTERNAL ASSEMBLY. ALIGN ON DOWEL PINS
	2. PLACE DISCHARGE PLATE INTO POSITION (FRONT DISCHARGE PLATE HAS THE LARGER CENTER HOLE)
	3. GENEROUSLY LUBRICATE SEALING AREAS WITH 525 VISCOSITY REFRIGERATION OIL
	4. ALIGN DOWEL PINS WITH HOLES IN FRONT HEAD. GENTLY LOWER ONTO INTERNAL ASSEMBLY
	5. INSTALL O-RING IN ANGLED GROOVE AT LOWER EDGE OF FRONT HEAD
	6. LUBRICATE INSIDE SURFACES OF SHELL WITH OIL CAUTION: USE CARE NOT TO DISLODGE O-RING WHEN SLIDING INTERNAL ASSEMBLY INTO SHELL
6. ASSEMBLE COMPRESSOR	1. SLIDE ASSEMBLY INTO SHELL, ALIGN OIL SUMP WITH OIL INTAKE TUBE HOLE
	2. INSTALL NEW OIL SEAL IN OIL PICK-UP

STEPS	KEY POINTS
	TUBE CAVITY AND INSERT TUBE 3. INSTALL REAR REED AND DISCHARGE PLATES OVER DOWEL PINS (REED RETAINERS FACING OUT) 4. INSTALL OIL PUMP GEARS WITH IDENTIFICATION MARKS UP 5. INSTALL SUCTION SCREEN IN REAR HEAD 6. LUBRICATE AND INSTALL O-RING 7. ALIGN REAR HEAD WITH DOWEL PINS. MAKE CERTAIN SUCTION SCREEN STAYS IN PLACE NOTE: IF REAR HEAD DOES NOT LINE UP WITH DOWEL PINS, SLIGHTLY ROTATE FRONT HEAD UNTIL REAR HEAD DROPS OVER DOWEL PINS 8. INSTALL NUTS AND TORQUE TO SPECIFICATIONS
7. INSTALL CLUTCH COIL AND PULLEY	1. INSTALL COIL AND SNAP RING 2. INSTALL PULLEY WITH PULLEY INSTALLATION, TOOL, INSTANT SNAP RING 3. INSTALL FRONT SEAL AND CLUTCH AS PER IX-B-2a(TS) 4. RECONNECT GROUND BATTERY CABLE
8. EVACUATE R-12 SYSTEM	1. REFER TO IX-B-1a(TS)
9. CHARGE R-12 SYSTEM	1. REFER TO IX-B-1b(TS)
10. LEAK TEST R-12 SYSTEM	1. REFER TO IX-A-3b(TS)
11. CLEAN WORK STATION	1. REFER TO IX-A-3(TS)

TASK: PRESSURE TEST COMPRESSOR (GENERAL MOTORS TYPE, 6 CYLINDER)

JOB: AIR CONDITIONING COMPRESSOR REPAIR

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, FENDER COVERS, PRESSURE TEST PLATE, SAFETY GOGGLES, R-12

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PRESSURE TEST COMPRESSOR (INTERNAL LEAKS)	NOTE: THIS OPERATION IS NECESSARY AFTER SEAL OR VALVE PLATE REPLACEMENT 1. ATTACH PRESSURE TEST PLATE TO REAR OF COMPRESSOR CAUTION: WEAR SAFETY GOGGLES 2. ATTACH ONLY HIGH SIDE HOSE TO HIGH SIDE OF PRESSURE TEST PLATE. CLOSE BOTH VALVES ON MANIFOLD GAGE 3. ATTACH R-12 SOURCE TO CENTER MANIFOLD HOSE AND OPEN VALVE ON ADAPTER 4. OPEN HIGH SIDE VALVE TO CHARGE HIGH PRESSURE SIDE OF COMPRESSOR WITH R-12. WHEN GAGE STABLIZES, CLOSE VALVE 5. IF GAGE READING DROPS TO 10 PSI OR UNDER IN 30 SECONDS OR LESS, IT INDICATES THAT COMPRESSOR IS LEAKING INTERNALLY. REPAIR LEAK AND PERFORM TEST AGAIN
2. PRESSURE TEST COMPRESSOR (EXTERNAL LEAKS)	1. WITH PRESSURE TEST PLATE ATTACHED, CONNECT BOTH MANIFOLD GAGE HOSES TO THEIR RESPECTIVE FITTINGS 2. ATTACH R-12 SOURCE TO CENTER MANIFOLD HOSE AND OPEN VALVE ON ADAPTER 3. OPEN BOTH MANIFOLD GAGE VALVES 4. TEST ENTIRE COMPRESSOR AREA, ESPECIALLY SEAL AREAS, FOR LEAKS

STEPS	KEY POINTS
	5. IF TEST IS SATISFACTORY, BLEED R-12 FROM COMPRESSOR, REMOVE GAGES AND TEST PLATE
3. CLEAN WORK STATION	1. REFER TO IX-A-1(TS)

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TASK: REPLACE PULLEY BEARING (YORK, TECUMSEH, AIR-TEMP AND GENERAL MOTORS TYPE, 6 CYLINDER)

JOB: AIR CONDITIONING COMPRESSOR REPAIR

TRADE: AUTOMECHANICS

TOOLS AND EQUIPMENT: FENDER COVERS, APPROPRIATE HAND TOOLS, RAGS, SPECIAL COMPRESSOR TOOLS, BEARINGS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. REMOVE PULLEY BEARING	NOTE: IT IS NOT NECESSARY TO DISCHARGE R-12 1. REMOVE DRIVE BELT 2. REMOVE CLUTCH ASSEMBLY AS PER IX-B-2(TS) AND IX-B-2a(TS) 3. REMOVE CLUTCH AND PULLEY AS AN ASSEMBLY EXCEPT ON G.M. TYPE COMPRESSORS 4. ON THE G.M. TYPE, FIRST REMOVE CLUTCH, THEN REMOVE SNAP RING AND USE PULLEY PULLER TO REMOVE PULLEY FROM COMPRESSOR 5. ON YORK, TECUMSEH AND AIR-TEMP, REMOVE EXTERNAL RETAINER AND SEPARATE CLUTCH AND PULLEY 6. REMOVE BEARING RETAINER 7. SUPPORT PULLEY ON OUTER EDGES, THEN PRESS BEARING OUT OF PULLEY CAUTION: DO NOT BEND PULLEY
2. INSTALL PULLEY BEARING	1. SUPPORT PULLEY ASSEMBLY 2. PRESS NEW BEARING INTO PULLEY. APPLY FORCE TO OUTER EDGES OF BEARING ONLY 3. INSTALL BEARING RETAINER 4. SLIDE PULLEY AND CLUTCH TOGETHER 5. INSTALL SNAP RING 6. ON G.M. TYPE, INSTALL PULLEY AND BEARING WITH PULLEY INSTALLING TOOL 7. INSTALL SNAP RING

STEPS	KEY POINTS
	8. INSTALL CLUTCH ASSEMBLY AS PER IX-B-2(TS) AND IX-B-2a(TS)
	9. INSTALL DRIVE BELT
3. CLEAN WORK STATION	1. REFER TO IX-A-1(TS)

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INSTRUCTOR'S PLAN IX-B-3(S)
MANIPULATIVE LESSON

TASK:	REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS
AIM:	STUDENT WILL BE ABLE TO REPAIR OR, IF NECESSARY, REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS IN AN AIR CONDITIONING SYSTEM. STUDENT WILL ALSO BE ABLE TO IDENTIFY PROBLEMS ASSOCIATED WITH EACH COMPONENT
TOOLS AND EQUIPMENT:	MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP
MATERIALS:	RAGS, R-12, REFRIGERANT OIL
TEACHING AIDS:	COMPLETE REFRIGERANT SYSTEM
REFERENCES:	AUTOMOTIVE SHOP MANUALS AUTO SERVICE AND REPAIR, STOCKEL, CH. 32 AUTOMOTIVE MECHANICS, CROUSE, CH. 43 AUTOMOTIVE ENCYCLOPEDIA, GOODHEART-WILLCOX PP. 635-646
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST BE FAMILIAR WITH AIR CONDITIONING NOMENCLATURE AND MUST HAVE A THOROUGH KNOWLEDGE OF MATERIALS COVERED IN PREVIOUS LESSONS
CHECKING STANDARDS:	1. PROPER HANDLING AND HOOKUP OF MANIFOLD GAGE SET 2. CONFORMING TO SAFETY STANDARDS 3. ABILITY TO REPAIR OR REPLACE COMPONENTS 4. POSITIVE WORK HABITS

I. PREPARATION (OF THE LEARNER-MOTIVATION)

BEING ABLE TO REPLACE COMPONENTS ASSOCIATED WITH THE AIR CONDITIONING SYSTEM IS MUCH LIKE YOUR FAMILY DOCTOR TRYING TO REPAIR YOUR PROBLEMS WHEN YOU DON'T FEEL WELL. AN AIR CONDITIONING MECHANIC MUST BE TALENTED AND WILLING TO WORK HARD TO ACCOMPLISH THE GOAL OF REPAIRING AN AIR CONDITIONING SYSTEM. IN THIS LESSON WE WILL TRY TO ACCOMPLISH THIS GOAL.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS THINGS TO REMEMBER TO DO OR SAY

1. DEMONSTRATE	1. PERFORM ALL TASKS 2. MAKE ALL KEY POINTS CLEAR AND PRECISE 3. EMPHASIZE SAFETY
2. VEHICLE PREPARATION	1. POSITION VEHICLE IN WORK STALL 2. SET PARKING BRAKE 3. DISCONNECT GROUND BATTERY CABLE
3. REMOVE RECEIVER/ DEHYDRATOR (DRIER)	CAUTION: WEAR SAFETY GOGGLES 1. DISCHARGE R-12 FROM SYSTEM, REFER TO IX-B-1(S) 2. REMOVE BRACKET HOLDING RECEIVER/ DEHYDRATOR (DRIER) STATIONARY 3. LOSSEN LINES ATTACHED TO RECEIVER/ DEHYDRATOR NOTE: ON LATE MODEL GENERAL MOTOR CARS, LOOSEN 6 BOLTS TO GAIN ACCESS TO DESICCANT BAG, LOCATED IN VIR ASSEMBLY CAUTION: USE BACK UP WRENCH TO PREVENT DAMAGE TO LINES 4. REMOVE RECEIVER/DEHYDRATOR FROM VEHICLE NOTE: PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIAL
4. INSTALL NEW RECEIVER/ DEHYDRATOR	1. INSPECT FLARED CONNECTIONS ON LINES ATTACHING RECEIVER/DEHY-DRATOR NOTE: WHEN REPLACING NEW RE-CEIVER/DEHYDRATOR, ADD 1 OUNCE OF REFRIGERANT OIL 2. REPLACE O-RINGS (IF USED) AND RE-CEIVER/DEHYDRATOR NOTE: ON LATE G.M. MODELS, RE-PLACE DESICCANT BAG ONLY 3. CONNECT LINES AND TORQUE TO SPECI-FICATIONS 4. RECONNECT BATTERY GROUND 5. EVACUATE, CHARGE, AND LEAK TEST R-12 SYSTEM AS PER IX-B-1(S) AND IX-A-1(S) UNLESS FURTHER COMPONENT REPLACEMENT IS NECESSARY
5. REMOVE CONDENSER	NOTE: IF THE R-12 SYSTEM HAS NOT

	PREVIOUSLY BEEN DISCHARGED, IT MUST BE DONE BEFORE STARTING ON THE REMOVAL PROCEDURE NOTE: REMOVAL PROCEDURE WILL VARY ACCORDING TO THE TYPE OF VEHICLE BEING REPAIRED 1. COMPLETE STEPS 1 AND 2 IN THIS LESSON NOTE: IF DISCHARGING OF R-12 IS NECESSARY, REFER TO IX-B-1(S) 2. REMOVE FAN SHROUD, GRILL SUPPORT, AND PANELS AS NECESSARY TO GAIN ACCESS TO CONDENSER 3. DISCONNECT CONDENSER INLET AND OUTLET LINES CAUTION: USE TWO WRENCHES TO PREVENT DAMAGE TO LINES NOTE: PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIALS 4. REMOVE CONDENSER BRACKETS AND REMOVE CONDENSER FROM CAR
6. INSTALL CONDENSER	1. INSPECT LINE CONNECTIONS FOR DAMAGE NOTE: IF NEW CONDENSER IS BEING INSTALLED, ADD 1 OUNCE OF REFRIGERATION OIL TO CONDENSER BEFORE INSTALLING 2. USE NEW O-RINGS, COAT WITH REFRIGERATION OIL 3. LOWER CONDENSER INTO PLACE, ATTACH BRACKETS 4. CONNECT LINES AND TORQUE TO SPECICATIONS 5. REINSTALL REMOVED PARTS SURROUNDING CONDENSER 6. RECONNECT BATTERY GROUND 7. EVACUATE, CHARGE, AND LEAK TEST R-12 SYSTEM AS PER IX-B-1(S) AND IX-A-3 (S) UNLESS FURTHER COMPONENT REPLACEMENT IS NECESSARY
7. REMOVE EXPANSION VALVE	NOTE: IF R-12 SYSTEM HAS NOT PREVIOUSLY BEEN DISCHARGED, IT MUST BE DONE BEFORE STARTING THE REMOVAL

	PROCEDURE NOTE: REMOVAL PROCEDURE WILL VARY ACCORDING TO THE TYPE OF VEHICLE BEING REPAIRED 1. COMPLETE STEPS 1 AND 2 IN THIS LESSON 2. DISCHARGE R-12 SYSTEM IF NECESSARY. REFER TO IX-B-1(S) 3. REMOVE CAPILLARY TUBE IF APPLICABLE) 4. REMOVE LINES ATTACHING TO EXPANSION VALVE CAUTION: USE TWO WRENCHES TO PREVENT DAMAGE TO LINES NOTE: PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIAL 5. REMOVE ATTACHING BRACKETS AND REMOVE EXPANSION VALVE FROM VEHICLE NOTE: ON LATE MODEL G.M. CARS, THE EXPANSION VALVE IS LOCATED INSIDE THE VIR ASSEMBLY
8. INSTALL EXPANSION VALVE	1. INSPECT LINE CONNECTIONS FOR DAMAGE 2. USE NEW O-RINGS, COAT WITH REFRIGERATION OIL 3. CONNECT LINES TO EXPANSION VALVE 4. ATTACH BRACKETS 5. TORQUE LINES TO SPECIFICATIONS 6. RECONNECT BATTERY GROUND CABLE 7. EVACUATE, CHARGE, AND LEAK TEST R-12 SYSTEM AS PER IX-B-1(S) AND IX-A-3(S) UNLESS FURTHER COMPONENT REPLACEMENT IS NECESSARY
9. REMOVE EVAPORATOR	NOTE: IF R-12 SYSTEM HAS NOT PREVIOUSLY BEEN DISCHARGED, IT MUST BE DONE BEFORE STARTING THE REMOVAL PROCEDURE NOTE: REMOVAL PROCEDURE WILL VARY ACCORDING TO THE TYPE OF VEHICLE BEING REPAIRED 1. COMPLETE STEPS 1 AND 2 IN THIS LESSON

2. DISCHARGE R-12 SYSTEM IF NECESSARY. REFER TO IX-B-1(S)
   NOTE: SOME VEHICLES REQUIRE THE REMOVAL OF DUCTWORK AND GLOVE BOX INSIDE OF VEHICLE
3. REMOVE BOLTS HOLDING CASE TO BULKHEAD
4. REMOVE OTHER ATTACHING HARDWARE
5. REMOVE LINES
   NOTE: PLUG HOLES TO PREVENT ENTRY OF FOREIGN MATERIAL
6. REMOVE EVAPORATOR
   NOTE: SOME EVAPORATORS WILL BE REMOVED FROM INSIDE THE VEHICLE, OTHERS FROM ENGINE COMPARTMENT
7. CHECK AND CLEAN EVAPORATOR DRAIN

10. REPLACE EVAPORATOR

1. INSPECT CONNECTIONS FOR DAMAGE
2. USE NEW O-RINGS, COAT WITH REFRIGERATION OIL
   NOTE: IF NEW EVAPORATOR IS BEING INSTALLED, ADD 3 OUNCES OF REFRIGERATION OIL
3. POSITION EVAPORATOR IN PLACE, CONNECT LINES
4. TORQUE TO SPECIFICATIONS
5. REPLACE ALL DUCTWORK AND HARDWARE PREVIOUSLY REMOVED
6. RECONNECT BATTERY GROUND
   NOTE: EVACUATE, CHARGE, AND LEAK TEST R-12 SYSTEM AS PER IX-B-1(S) AND IX-B-1(S) UNLESS FURTHER COMPONENT REPLACEMENT IS NECESSARY

11. REMOVE POA VALVE OR EPR VALVE

NOTE: IF R-12 SYSTEM HAS NOT PREVIOUSLY BEEN DISCHARGED, IT MUST BE DONE BEFORE STARTING THE REMOVAL PROCEDURE
NOTE: REMOVAL PROCEDURE WILL VARY ACCORDING TO THE TYPE OF VEHICLE BEING REPAIRED

1. COMPLETE STEPS 1 AND 2 IN THIS LESSON
2. DISCHARGE R-12 SYSTEM IF NECESSARY. REFER TO IX-B-1(S)

3. REMOVE LINES ATTACHING TO VALVE
NOTE: LATE MODEL G.M. CARS HAS POA VALVE LOCATED IN VIR ASSEMBLY
NOTE: PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIAL
4. REMOVE ATTACHING BRACKETS
5. REMOVE VALVE

12. INSTALL POA VALVE OR EPR VALVE

1. INSPECT CONNECTIONS FOR DAMAGE
2. USE NEW O-RINGS, COAT WITH REFRIGERATION OIL
3. POSITION VALVE INTO PLACE, ATTACH LINES
4. TORQUE TO SPECIFICATIONS
5. RECONNECT NEGATIVE BATTERY CABLE
NOTE: EVACUATE, CHARGE, AND LEAK TEST R-12 SYSTEM AS PER IX-B-1(S) AND IX-A-3(S) UNLESS FURTHER COMPONENT REPLACEMENT IS NECESSARY

13. REMOVE HOSES AND LINES

NOTE: IF R-12 SYSTEM HAS NOT PREVIOUSLY BEEN DISCHARGED, IT MUST BE DONE BEFORE STARTING THE REMOVAL PROCEDURE
1. COMPLETE STEPS 1 AND 2 IN THIS LESSON
2. DISCHARGE R-12 SYSTEM IF NECESSARY. REFER TO IX-B-1(S)
3. REMOVE LINE OR HOSE CONNECTIONS
CAUTION: USE TWO WRENCHES TO PREVENT DAMAGE TO LINES
NOTE: PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIAL
4. REMOVE BRACKETS HOLDING LINE OR HOSE FROM VEHICLE

14. INSTALL HOSE AND LINE

1. CHECK CONNECTIONS FOR DAMAGE
2. USE NEW O-RINGS, COAT WITH REFRIGERATION OIL
3. INSTALL HOSE OR LINE INTO PLACE
NOTE: WHEN ROUTING THROUGH OR AROUND OTHER COMPONENTS, SECURE IN A SAFE PLACE TO AVOID DAMAGE TO HOSE OR LINE
4. TORQUE TO SPECIFICATIONS

	5. RECONNECT BATTERY GROUND NOTE: EVACUATE, CHARGE, AND LEAK TEST AS PER IX-B-1(S) AND IX-A-3(S) UNLESS FURTHER COMPONENT REPLACEMENT IS NECESSARY
15. CLEAN WORK STATION	1. REFER TO IX-A-1(S)

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

1. STUDENTS TO PRACTICE ON TASKS AND ORALLY REPEAT AND REVIEW STEPS AND KEY POINTS
2. OBSERVE AND RETEACH, IF NEED ARISES
3. CHECK STUDENTS FOR PROPER AND SAFE PRACTICES

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENTS ABILITY)

ASSIGN STUDENTS TO WORK ON THEIR OWN TO PERFORM TASKS

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

1. BRIEFLY REPEAT STEPS FROM STAGE II
2. EMPHASIZE KEY POINTS
3. ANSWER ANY QUESTIONS THE STUDENT MAY HAVE
4. EMPHASIZE SAFETY

SUGGESTED READING FOR THE STUDENT:

AUTOMOTIVE SHOP MANUALS
AUTO SERVICE AND REPAIR, STOCKEL, CH. 32
AUTOMOTIVE MECHANICS, CROUSE, CH. 43
AUTOMOTIVE ENCYCLOPEDIA, GOODHEART-WILLCOX, PP. 635-646

THE NEXT LESSON IS: X-B-1(S) "INSPECT VEHICLE"

JOB:	REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS
TOOLS AND EQUIPMENT:	MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS, R-12, REFRIGERANT OIL
GENERAL INSTRUCTIONS:	THIS JOB IS AN IMPORTANT PART OF REPAIRING THE AIR CONDITIONING SYSTEM. BEFORE BEGINNING THIS JOB THE STUDENT MUST BE FAMILIAR WITH AIR CONDITIONING NOMENCLATURE. THE STUDENT MUST KNOW HOW TO DISCHARGE, EVACUATE, CHARGE, AND LEAK TEST THE R-12 SYSTEM. THE STUDENT MUST CONSTANTLY BE AWARE OF THE DANGER INVOLVED IN SERVICING THE R-12 SYSTEM.
PROCEDURES AND/OR TASKS:	IX-A-2(TS) DISCHARGE AIR CONDITIONING SYSTEM
CHECK POINTS:	BEFORE PROCEEDING FURTHER, HAVE INSTRUCTOR CHECK WORK
	IX-B-3 (TS) REPLACE RECEIVER/DEHYDRATOR
	IX-B-3a(TS) REPLACE CONDENSER
	IX-B-3b(TS) REPLACE EXPANSION VALVE
	IX-B-3c(TS) REPLACE EVAPORATOR
	IX-B-3d(TS) REPLACE POA OR EPR VALVE
	IX-B-3e(TS) REPLACE LINES AND HOSES
CHECK POINTS:	BEFORE PROCEEDING FURTHER, HAVE INSTRUCTOR CHECK WORK
	IX-B-1a(TS) EVACUATE AIR CONDITIONING SYSTEM
	IX-B-1b(TS) CHARGE AIR CONDITIONING SYSTEM
	IX-A-1c(TS) LEAK TEST AIR CONDITIONING SYSTEM
CHECK POINT:	BEFORE PROCEEDING FURTHER, HAVE INSTRUCTOR CHECK WORK
	IX-A-1(TS) CLEAN WORK STATION

TASK: REPLACE RECEIVER/DEHYDRATOR

JOB: REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS, R-12, REFRIGERANT OIL, RECEIVER/DEHYDRATOR

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN WORK STALL 2. SET PARKING BRAKE 3. DISCONNECT BATTERY GROUND
2. DISCHARGE R-12 SYSTEM	1. REFER TO IX-B-1(TS)
3. REMOVE RECEIVER/DEHYDRATOR	1. REMOVE BRACKET HOLDING RECEIVER/DEHYDRATOR IN PLACE 2. LOOSEN LINES ATTACHING TO RECEIVER/DEHYDRATOR NOTE: IN LATE MODEL G.M. CARS, LOOSEN 6 BOLTS TO GAIN ACCESS TO DESICCANT BAG, LOCATED IN VIR ASSEMBLY CAUTION: USE BACK-UP WRENCH TO PREVENT DAMAGE TO LINES 3. REMOVE RECEIVER / DEHYDRATOR FROM VEHICLE 4. PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIAL
4. INSTALL NEW RECEIVER/DEHYDRATOR	1. INSPECT LINE CONNECTIONS FOR DAMAGE 2. REPLACE O-RING, COAT WITH REFRIGERATION OIL NOTE: BEFORE REPLACING NEW RECEIVER/DEHYDRATOR, ADD 1 OUNCE REFRIGERATION OIL 3. CONNECT LINES AND TORQUE TO SPECIFICATIONS NOTE: ON LATE MODEL G.M. CARS, REPLACE DESICCANT BAG ONLY

STEPS	KEY POINTS
5. EVACUATE R-12 SYSTEM	REFER TO IX-B-1a(TS)
6. CHARGE R-12 SYSTEM	REFER TO IX-B-1b(TS)
7. LEAK TEST R-12 SYSTEM	REFER TO IX-A-1c(TS)
8. CLEAN WORK STATION	REFER TO IX-A-1 (TS)

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TASK: REPLACE CONDENSER

JOB: REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS, R-12, REFRIGERANT OIL, CONDENSER

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN WORK BAY 2. SET PARKING BRAKE 3. DISCONNECT BATTERY GROUND
2. DISCHARGE R-12 SYSTEM	1. REFER TO IX-B-1(TS)
3. REMOVE CONDENSER	1. REMOVAL PROCEDURE WILL VARY ACCORDING TO THE TYPE OF VEHICLE BEING REPAIRED 2. REMOVE FAN SHROUD, GRILL SUPPORT, AND PANELS AS NECESSARY TO GAIN ACCESS TO CONDENSER 3. DISCONNECT CONDENSER INLET AND OUTLET LINES CAUTION: USE TWO WRENCHES TO PREVENT DAMAGE TO LINES NOTE: PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIAL 4. REMOVE BRACKETS HOLDING CONDENSER IN PLACE 5. REMOVE CONDENSER
4. INSTALL CONDENSER	1. INSPECT LINE CONNECTIONS FOR DAMAGE NOTE: BEFORE NEW CONDENSER IS INSTALLED, ADD 1 OUNCE OF REFRIGERATION OIL 2. USE NEW O-RINGS, COAT WITH REFRIGERATION OIL 3. LOWER CONDENSER INTO PLACE, ATTACH BRACKETS 4. CONNECT LINES 5. TORQUE TO SPECIFICATIONS

STEPS	KEY POINTS
	6. REINSTALL REMOVED PARTS SURROUNDING CONDENSER 7. RECONNECT BATTERY GROUND
5. EVACUATE R-12 SYSTEM	REFER TO IX-B-1a(TS)
6. CHARGE R-12 SYSTEM	REFER TO IX-B-1b(TS)
7. LEAK TEST R-12 SYSTEM	REFER TO IX-A-1c(TS)
8. CLEAN WORK STATION	REFER TO IX-A-1 (TS)

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TASK SHEET IX-B-3b(TS)

TASK: REPLACE EXPANSION VALVE

JOB: REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE STE, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS, R-12, REFRIGERANT OIL, EXPANSION VALVE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN WORK STALL 2. SET PARKING BRAKE 3. DISCONNECT NEGATIVE BATTERY CABLE GROUND
2. DISCHARGE R-12 SYSTEM	1. REFER TO IX-B-1(TS)
3. REMOVE EXPANSION VALVE	1. REMOVAL PROCEDURE WILL VARY ACCORDING TO THE TYPE OF VEHICLE BEING REPAIRED 2. REMOVE CAPILLARY TUBE (IF APPLICABLE) 3. REMOVE LINES ATTACHING TO EXPANSION VALVE CAUTION: USE TWO WRENCHES TO PREVENT DAMAGE TO LINES NOTE: PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIAL 4. REMOVE ATTACHING BRACKET AND REMOVE EXPANSION VALVE
4. INSTALL EXPANSION VALVE	1. INSPECT LINE CONNECTION FOR DAMAGE 2. USE NEW O-RINGS, COAT WITH REFRIGERATION OIL 3. CONNECT LINES TO EXPANSION VALVE 4. ATTACH BRACKETS 5. TORQUE ALL FASTENERS TO SPECIFICATIONS 6. RECONNECT BATTERY GROUND
5. EVACUATE R-12 SYSTEM	REFER TO IX-B-1a(TS)
6. CHARGE R-12 SYSTEM	REFER TO IX-B-1b(TS)

STEPS	KEY POINTS
7. LEAK TEST R-12 SYSTEM	REFER TO IX-A-1c(TS)
8. CLEAN WORK STATION	REFER TO IX-A-1 (TS)

TASK SHEET IX-B-3c(TS)

TASK: REPLACE EVAPORATOR

JOB: REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS R-12, REFRIGERANT OIL, EVAPORATOR

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN WORK STALL 2. SET PARKING BRAKE 3. DISCONNECT BATTERY GROUND
2. DISCHARGE R-12 SYSTEM	1. REFER TO IX-B-1(TS)
3. REMOVE EVAPORATOR	1. REMOVAL PROCEDURE WILL VARY ACCORDING TO THE TYPE OF VEHICLE BEING REPAIRED 2. SOME VEHICLES WILL REQUIRE REMOVAL OF GLOVE BOX AND DUCTWORK INSIDE OF VEHICLE 3. REMOVE BOLTS HOLDING CASE TO BULKHEAD 4. REMOVE OTHER ADDITIONAL HARDWARE 5. REMOVE LINES ATTACHED TO EVAPORATOR CAUTION: USE TWO WRENCHES TO PREVENT DAMAGE TO LINES NOTE: PLUG LINES TO PREVENT ENTRY OF FOREIGN MATERIAL 6. REMOVE EVAPORATOR 7. CHECK AND CLEAN EVAPORATOR DRAIN
4. REPLACE EVAPORATOR	1. INSPECT LINE CONNECTIONS FOR DAMAGE 2. USE NEW O-RINGS, COAT WITH REFRIGERATION OIL 3. POSITION EVAPORATOR IN PLACE CAUTION: THIS IS A DELICATE PIECE OF EQUIPMENT

STEPS	KEY POINTS
	NOTE: IF NEW EVAPORATOR IS BEING INSTALLED, ADD 3 OUNCES OF REFRIGERATION OIL BEFORE INSTALLING
	4. CONNECT LINES AND TORQUE TO SPECIFICATIONS
	5. REPLACE ALL DUCTWORK AND HARDWARE PREVIOUSLY REMOVED
	6. RECONNECT BATTERY GROUND
5. EVACUATE R-12 SYSTEM	REFER TO IX-B-1a(TS)
6. CHARGE R-12 SYSTEM	REFER TO IX-B-1b(TS)
7. LEAK TEST R-12 SYSTEM	REFER TO IX-A-1c(TS)
8. CLEAN WORK STATION	REFER TO IX-A-1 (TS)

TASK: REPLACE POA OR EPR VALVE

JOB: REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS, R-12, REFRIGERANT OIL, POA AND EPR VALVES

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN WORK STALL 2. SET PARKING BRAKE 3. DISCONNECT BATTERY GROUND
2. DISCHARGE R-12 SYSTEM	1. REFER TO IX-B-1(TS)
3. REMOVE POA OR EPR VALVE	1. REMOVAL PROCEDURE WILL VARY ACCORDING TO THE TYPE OF VEHICLE BEING REPAIRED 2. REMOVE LINES ATTACHING TO VALVE NOTE: LATE MODEL G.M. CARS HAVE THE POA VALVE LOCATED IN THE VIR ASSEMBLY. CHRYSLER PRODUCTS HAVE EPR LOCATED IN COMPRESSOR 3. REMOVE ATTACHING BRACKETS NOTE: PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIAL 4. REMOVE VALVE FROM VEHICLE
4. INSTALL POA OR EPR VALVE	1. INSPECT CONNECTIONS FOR DAMAGE 2. USE NEW O-RINGS, COAT WITH REFRIGERATION OIL 3. POSITION VALVE INTO PLACE, ATTACH LINES 4. TORQUE TO SPECIFICATIONS 5. RECONNECT BATTERY GROUND
5. EVACUATE R-12 SYSTEM	REFER TO IX-B-1a(TS)
6. CHARGE R-12 SYSTEM	REFER TO IX-B-1b(TS)
7. LEAK TEST R-12 SYSTEM	REFER TO IX-A-1c(TS)
8. CLEAN WORK STATION	REFER TO IX-A-1 (TS)

TASK: REPLACE LINES AND HOSES

JOB: REPLACE AIR CONDITIONING REFRIGERANT COMPONENTS

TRADE: AUTOMECHANICS

TOOLS AND MATERIALS: MANIFOLD GAGE SET, SERVICE VALVE WRENCH, FENDER COVERS, APPROPRIATE HAND TOOLS, SAFETY GOGGLES, VACUUM PUMP, RAGS, R-12, REFRIGERANT OIL, LINES AND HOSES

TASK BREAKDOWN:

STEPS	KEY POINTS
1. PREPARE VEHICLE	1. POSITION VEHICLE IN WORK STALL 2. SET PARKING BRAKE 3. DISCONNECT GROUND BATTERY CABLE
2. DISCHARGE R-12 SYSTEM	1. REFER TO IX-B-1(TS)
3. REMOVE LINES AND HOSES	1. REMOVAL PROCEDURE WILL VARY ACCORDING TO TYPE OF VEHICLE BEING REPAIRED 2. REMOVE LINE OR HOSE CONNECTIONS CAUTION: USE TWO WRENCHES TO PREVENT DAMAGE TO LINES NOTE: PLUG OPENINGS TO PREVENT ENTRY OF FOREIGN MATERIALS 3. REMOVE BRACKETS HOLDING LINE OR HOSE IN PLACE
4. INSTALL LINES AND HOSES	1. CHECK LINE CONNECTIONS FOR DAMAGE 2. USE NEW O-RING, COAT WITH REFRIGERATION OIL 3. INSTALL LINE OR HOSE INTO PLACE NOTE: WHEN ROUTING THROUGH OR AROUND OTHER COMPONENTS, SECURE IN A SAFE PLACE TO AVOID FURTHER DAMAGE TO LINE OR HOSE 4. TORQUE TO SPECIFICATIONS 5. RECONNECT GROUND BATTERY CABLE
5. EVACUATE R-12 SYSTEM	REFER TO IX-B-1a(TS)
6. CHARGE R-12 SYSTEM	REFER TO IX-B-1b(TS)
7. LEAK TEST R-12 SYSTEM	REFER TO IX-A-1c(TS)
8. CLEAN WORK STATION	REFER TO IX-A-1 (TS)

INFORMATION SHEET
ON
AIR CONDITIONING SYSTEM

IX-B-1(IS)

SUBJECT: Automatic Temperature Control Functional Test

INTRODUCTORY INFORMATION:

To diagnose an air conditioner problem in the shortest time and with the least effort, it is essential to follow a logical service procedure. When customer complaints are encountered, it is necessary to verify the complaint and isolate the location or possible location of the difficulty. Special testers are available which can be connected into the ATC system. These testers can then force the automatic units to operate and thus verify their proper operation.

Before resorting to a special tester, it is considered wise to make a visual and operational check of the system. An operational test can be made by positioning the control lever in each mode position, moving the temperature selector lever from low to high ranges and observing (1) air temperature change, (2) blower speed variation, and (3) air flow changes according to selector positions.

GENERAL INFORMATION:

An air conditioning system that is operating properly will perform in a certain way during a performance test according to the temperature setting and control lever setting. As an example, a system operating properly on a warm day and set on high range will deliver cool air from the air conditioning outlets when the temperature is set at 65°F. As the temperature selector is moved to 85°F., the air flow will switch to the floor outlets, and a progressive decrease and then an increase of blower speed will be noticed. This indicates that the operational parts, transducer, sensors, and power servo, are properly carrying out their assigned function.

The following automatic temperature control functional test should be performed before proceeding to a more specialized test:

Automatic Temperature Control Functional Test

Control Setting	Proper Operation of System
DEF DIAL AT 85°	Air should be delivered out of defrost outlets at a fixed high blower speed. Some air bleeds out of floor heater
↓	
BI-LEVEL DIAL AT 75°	Air should be delivered from both the A/C and heater outlets at a reduced blower speed. Only a small portion of air will come out the defrost outlet
↓	
HI DIAL AT 65°	Air should be delivered out the A/C outlets at a fixed high blower speed and cool to cold temperature. The recirculating air door should open (blower noise increases). Door movement will be slow because of vacuum delay plug
↓	
AUTO DIAL AT 65°	After 45 seconds the A/C discharge air should drop to 50°F or lower (may be slightly higher in 90°F or above ambients). Recirc air door should close (noise level will drop)
↓	
AUTO DIAL AT 85°	Blower speeds should drop (Hi - M^3 - M^2 - M^1 - etc.) and discharge air temperature should increase. Depending on the temperature in the work area, the air delivery mode should change from the A/C outlets to the heater outlets
↓	
LO DIAL AT 85°	Air should be delivered at a fixed low blower speed
↓	
VENT DIAL AT 85°	Air should be discharged from the A/C outlets at a fixed low blower speed. The A/C compressor should not operate
↓	
OFF DIAL AT 65°	Air should be discharged out the heater outlet at a fixed low blower speed. No A/C compressor operation

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

IX-B-3(1)

SUBJECT:	AIR CONDITIONING AUTOMATIC CLIMATE CONTROL SYSTEM
AIM:	THE STUDENT WILL BE ABLE TO IDENTIFY THE VARIOUS PARTS OF THE AUTOMATIC CLIMATE CONTROL AIR CONDITIONING SYSTEM AND EXPLAIN THE FUNCTION EACH PART PLAYS IN THE OVERALL OPERATION OF THE AIR CONDITIONING SYSTEM USED ON SOME MODELS OF GENERAL MOTORS VEHICLES.
TEACHING AIDS:	TRANSPARENCIES I. ED. IX FIGS. 62-68; INFORMATION SHEET IX-B-1(IS) "AUTOMATIC TEMPERATURE CONTROL FUNCTIONAL TEST"; CHARTS: DIAGNOSIS, MAINTENANCE, AND ADJUSTMENTS
MATERIALS:	CHALK
REFERENCES:	GENERAL MOTORS SERVICE MANUAL
PREREQUISITE EXPERIENCE OF THE LEARNER:	THE STUDENT MUST HAVE SUCCESSFULLY COMPLETED PREVIOUS LESSONS IN MAJOR BLOCK IX, AND SHOW CONTINUED INTEREST IN LEARNING IN THE FIELD OF REFRIGERATION AND AIR CONDITIONING AS APPLIED TO AUTOMOTIVE TRANSPORTATION TECHNOLOGY

I. PREPARATION (OF THE LEARNER - MOTIVATION)

TO DIAGNOSE AN AIR CONDITIONER PROBLEM IN THE SHORTEST TIME AND WITH THE LEAST EFFORT, IT IS ESSENTIAL TO FOLLOW A LOGICAL SERVICE PROCEDURE. FOLLOW A RECOMMENDED DIAGNOSIS PROCEDURE TO ISOLATE THE PROBLEM AREA TO ONE OF THE FOLLOWING AREAS: TEMPERATURE CONTROL, BLOWER CONTROL, VACUUM PROBLEMS, OR REFRIGERATION. THE PRIMARY FUNCTION OF THE TEMPERATURE CONTROL CIRCUIT IS TO DETERMINE THE CORRECT TEMPERATURE OF THE AIR TO BE DISCHARGED INTO THE PASSENGER COMPARTMENT BY SETTING THE AIR MIX DOOR POSITION. SOME EXAMPLES OF TEMPERATURE CONTROL PROBLEMS ARE: (1) SYSTEM OPERATES AT MAXIMUM AIR CONDITIONING (NO HEAT): (2) AT MAXIMUM HEAT (NO AIR CONDITIONING): (3) TEMPERATURE DIAL DOOR NOT PROVIDING COMFORT, AND (4) POOR HEATING OR POOR COOLING.

MANY TEMPERATURE CONTROL PROBLEMS RESULT FROM POOR ELECTRICAL OR VACUUM LINE CONNECTIONS. MANY MALFUNCTION PROBLEMS CAN BE EASILY SOLVED BY USING CHECKING PROCEDURE DIAGRAMS AND CHARTS FROM THE AIR CONDITIONING SECTION OF THE MANUFACTURER'S SERVICE MANUAL FOR THE YEAR AND MODEL BEING SERVICED.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. GENERAL INFORMATION	THE CLIMATE CONTROL SYSTEM: 1. PROVIDES AND MAINTAINS A SET COMFORT LEVEL WITHIN A VEHICLE NOTE: PROVIDES HEAT IN COLD WEATHER AND COOL DEHUMIDIFIED AIR IN WARM WEATHER 2. PROVIDES FOR MEANS OF DE-ICING OR DE-FOGGING 3. REQUIRES LITTLE IF ANY CONTROL CHANGE 4. ALLOWS DRIVER TO SELECT TEMPERATURE AND BLOWER RANGE 5. PROVIDES CONSTANT INTERIOR TEMPERATURE REGARDLESS OF OUTSIDE TEMPERATURE 6. ADJUSTS DURING DRIVING TO OUTSIDE CONDITIONS 7. FUNCTIONS OF THE SYSTEM ARE CONTROLLED BY VARIOUS AUTOMATIC CONTROLS 8. PROVIDES FOR AN AUTOMATIC INCREASE OR DECREASE OF BLOWER SPEED TO MAINTAIN TEMPERATURE SETTING ON DIAL
B. CLIMATE CONTROLS SHOW TRANSPARENCY. FIGURE 62	1. DETERMINE THE TYPE OF CONDITION TO BE USED NOTE: DETERMINE HEATING, COOLING, DE-FROSTING, DE-ICING, OR BI-LEVEL CONDITION 2. CONSIST OF TWO MAJOR CONTROLS a. CONTROL PANEL b. PROGRAMMER
1. CONTROL PANEL	1. DETERMINES THE SELECTION OF CONDITION, SUCH AS HEATING, COOLING, ETC. 2. CONSISTS OF EITHER TWO OPERATIONAL LEVERS, OR A LEVER AND DIAL a. ON AND OFF SELECTOR LEVER NOTE: CONSISTS OF HIGH AND LOW

POSITION, AND MAY INCLUDE DE-ICE, DE-FROST, AND BI-LEVEL POSITION
b. TEMPERATURE DIAL
NOTE: SETS THE REQUIRED IN-CAR TEMPERATURE
NOTE: TEMPERATURE SELECTION RANGES FROM 65° TO 85°
3. CONTAINS OVERRIDE SYSTEM FOR DE-ICING, DE-FROSTING, OR BI-LEVEL CONTROL

2. PROGRAMMER
1. CARRIES OUT THE FUNCTION OF THE CONTROL PANEL SELECTION
2. REFERRED TO AS AN AUTOMATIC TEMPERATURE CONTROL BOX (ATC BOX) OR POWER SERVO BOX
3. CONTAINS AUXILIARY COMPONENTS TC CARRY OUT ASSIGNED FUNCTION
a. AMBIENT AIR SENSOR
b. IN-CAR SENSOR
c. TRANSDUCER - AMPLIFIER
d. POWER SERVO
e. AMBIENT SWITCH
f. WATER TEMPERATURE SWITCH
g. OVER-RIDE SWITCH

C. DIVISION OF DIAGNOSIS
FOUR DIVISIONS FOR AIR CONDITIONING (CLIMATE CONTROL) DIAGNOSIS ARE:
1. MECHANICAL SYSTEM
2. ELECTRICAL SYSTEM
3. VACUUM SYSTEM
4. SENSOR

1. MECHANICAL SYSTEM
1. THE TERM "MECHANICAL" REFERS TO THAT PART OF THE REFRIGERATION SYSTEM OPERATED BY MEANS OTHER THAN ELECTRICAL OR VACUUM
2. THIS ALSO INCLUDES ALL MECHANICAL WORKING PARTS
NOTE: COVERED IN PREVIOUS LESSONS

2. ELECTRICAL SYSTEM
1. A SOURCE OF POWER (BATTERY) IS INCLUDED IN ALL ELECTRICAL SYSTEMS
2. BLOWER CONTROL CIRCUIT
a. PROGRAMMER
b. SENSOR

SHOW TRANSPARENCIES FIGURES 63-64

c. TRANSDUCER - AMPLIFIER
d. LOW-RELAY
e. AUTO-RELAY
f. BLOWER MOTOR
g. FUSIBLE LINK

3. COMPRESSOR CIRCUIT
a. CLUTCH COIL
b. AMBIENT SWITCH
c. ENGINE TEMPERATURE
d. FUSIBLE LINK

3. VACUUM SYSTEM
SHOW TRANSPARENCY: FIGURE 65

1. THE TERM "VACUUM" REFERS TO THAT PART OF THE REFRIGERATION SYSTEM CONTROLLED OR OPERATED BY VACUUM
2. SOME CONTROLS ARE BOTH VACUUM AND ELECTRICALLY OPERATED
a. PROGRAMMER
b. TRANSDUCER
c. AMPLIFIER
d. RESTRICTOR
e. VACUUM LEVEL VALVE
f. SUPPLY VACUUM
g. DOOR ACTUATORS
h. HEATER WATER VALVE

4. SENSOR

SHOW TRANSPARENCIES: FIGURES 66-67

1. THE TERM "SENSOR" REFERS TO THAT PART OF THE REFRIGERATION SYSTEM, ELECTRICALLY AND VACUUM-CONTROLLED, THAT "SENSES" THE INSIDE AND OUTSIDE TEMPERATURES AND REACTS ACCORDING TO TEMPERATURE SELECTION
2. THE SENSORS ARE USUALLY LOCATED INSIDE VEHICLE UNDER INSTRUMENT PANEL AND INSIDE ENGINE COMPARTMENT ON AIR INLET ASSEMBLY

D. SEQUENCE OF DIAGNOSIS

1. OBVIOUS SYMPTOMS OF AIR CONDITIONING MALFUNCTION MAY BE DETECTED BY SIGHT, SOUND, AND FEEL, SUCH AS VISUAL FAULTS, EXCESS NOISE, AND LACK OF COOLING OR CIRCULATION OF AIR
2. THE FOLLOWING IS AN APPROXIMATE

CHECKING ORDER WHEN THE CAUSE FOR POOR PERFORMANCE IS NOT KNOWN
a. VISUAL INSPECTION
b. TEMPERATURE CONTROL FUNCTION
c. BLOWER
d. AUXILIARY VACUUM
e. REFRIGERATION

1. VISUAL

1. A VISUAL INSPECTION, IN MANY INSTANCES, WILL REVEAL THE NATURE OF MALFUNCTION BY EASILY ACCESSIBLE UNDER HOOD AND INSTRUMENT PANEL CHECKS OF ELECTRICAL AND VACUUM CONNECTIONS
2. THE FOLLOWING QUICK CHECKS ARE CONDUCTED TO DETERMINE POSSIBLE CAUSE OF PROBLEM
   a. DRIVE BELT CONDITION
   b. AIR FLOW RESTRICTION
   c. ELECTRICAL CONNECTORS AND WIRING
   d. VACUUM LINES
   e. MECHANICAL CONDITION

2. TEMPERATURE CONTROLS

1. CHECK AIR CONDITIONING TEMPERATURE CONTROL OPERATION BY RUNNING ENGINE AT 1000 RPM OR HIGHER AND FOLLOWING CHECKING SEQUENCE FUNCTIONAL TEST FROM MANUFACTURER'S SERVICE MANUAL
   NOTE: REVIEW INFORMATION SHEET

HANDOUT INFORMATION SHEET IX-B-1(IS)

2. MANY TEMPERATURE CONTROL PROBLEMS RESULT FROM POOR ELECTRICAL OR VACUUM LINE CONNECTIONS
   a. DISCONNECTED SENSOR
   b. POOR SENSOR CONNECTION
   c. OPEN AMPLIFIER POWER FEED
   d. DISCONNECTED VACUUM HOSE
   e. LEAK IN AUXILIARY VACUUM CIRCUIT
3. USE OF APPROVED TYPE TESTER WILL GREATLY AID IN FINDING SOURCE OF TROUBLE

NOTE: SHOW TESTER

3. BLOWER

SHOW TRANSPARENCY: FIGURE 63

1. BLOWER CONTROL CAN BE DIVIDED INTO TWO SEPARATE CATEGORIES
   a. BLOWER TURN-ON
   b. BLOWER SPEED
2. BLOWER TURN-ON IS ACCOMPLISHED WHEN A GROUND PATH IS COMPLETED FOR EITHER "LO" OR "AUTO" RELAY COIL
3. RELAY COIL GROUNDS ARE COMPLETED BY:
   a. DELAY THERMOSWITCH FOR HEATER WINTER OPERATION
   b. IN-CAR SWITCH FOR IMMEDIATE TURN-ON SUMMER OPERATION
   c. DEFROST MANUAL OVERRIDE BLOWER SPEED CONTROL IS ACCOMPLISHED BY ACUATING ONLY THE LOW BLOWER RELAY IN THE "OFF", "ECONOMY", AND "LO" POSITIONS, BY SELECTIVE USE OF THE RESISTORS ON THE BLOWER CIRCUIT BOARD IN THE "AUTO" AND "BI-LEVEL" LEVER SETTINGS, OR BY HIGH BLOWER OVERRIDE CIRCUIT IN "HI" AND "DEFROST" LEVER POSITIONS

4. AUXILIARY VACUUM

SHOW TRANSPARENCY: FIGURE 68

1. AUXILIARY VACUUM CIRCUITS IN THE TEMPERATURE CONTROL SYSTEM DOES NOT AFFECT THE DISCHARGED AIR TEMPERATURE, BUT DOES AFFECT THE AIR ROUTING
2. THE AUXILIARY VACUUMS ARE:
   a. UPPER MODE DOOR
   b. LOWER MODE DOOR
   c. DEFROST BLEED
   d. DEFROST DOOR
   e. RECIRCULATING DOOR
   f. HEATER WATER VALVE
   g. AUXILIARY VACUUM CIRCUIT CHECK VALVE
   h. COMPRESSOR ELECTRICAL CIRCUIT

3. A LEAK IN THE CIRCUIT MAY REDUCE THE VACUUM IN ANOTHER CIRCUIT TO CAUSE A MALFUNCTION IN A SECOND CIRCUIT. ONCE A PROBLEM HAS BEEN ISOLATED TO A SPECIFIC CIRCUIT. CHECKING VACUUM CONNECTIONS AT ONE OR TWO POINTS WILL GENERALLY LOCATE THE PROBLEM

5. REFRIGERATION

1. A PROPERLY OPERATING REFRIGERATION SYSTEM WILL MAINTAIN EVAPORTOR CORE COOLING SURFACES AT 32^{C}F WHEN REFRIGERATION IS REQUIRED, DEPENDING ON ENGINE SPEED AND HEAT LOAD
2. A REFRIGERATION PROBLEM EXISTS WHEN THERE IS A DEFECT IN ONE OF THE REFRIGERATION COMPONENTS OR IN THE OVERALL SYSTEM WHICH INTERFERES WITH THIS FUNCTION AND AFFECTS THE COMFORT LEVEL
   a. CAR TEMPERATURE LOWER THAN 32^{O}F WILL FREEZE CONDENSATE, BLOCK FREE FLOW OF AIR, AND CAUSE LOSS OF COOLING
   b. EXCESS BUGS, LEAVES, ETC. ON CONDENSER WILL BLOCK AIR FLOW, CAUSE HIGHER - THAN NORMAL HEAD PRESSURE, AND LOSS OF COOLING
   c. EXCESS REFRIGERANT, OIL, OR AIR IN SYSTEM WILL CAUSE HIGHER THAN NORMAL HEAD PRESSURE, INTERNAL CORROSION OF PARTS, AND LOSS OF COOLING

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

ESSAY

1. WHAT ARE THE FOUR MAJOR REQUIREMENTS FOR AUTOMATIC CLIMATE CONTROL REFRIGERATION SYSTEM OPERATION?

ANSWER: (A) MECHANICAL, (B) ELECTRICAL, (C) VACUUM, (D) SENSOR

2. WHAT ARE THE REQUIREMENTS OF THE VACUUM SYSTEM?

ANSWER: (A) COMPRESSOR MOVES REFRIGERANT THROUGHOUT SYSTEM CAUSING CHANGE IN STATE, (B) CLUTCH DETERMINES COMPRESSOR ACTION, (C) DASH CONTROLS ARE MANUALLY OPERATED

3. WHAT ARE THE REQUIREMENTS OF THE ELECTRICAL SYSTEM?

ANSWER: (A) TURNS COMPRESSOR ON AND OFF, (B) DETERMINES BLOWER SPEED (C) OPERATES AMBIENT SENSOR, (D) OPERATES PROGRAMMER, (E) OPERATES IN CAR SENSOR, (F) OPERATES THERMASWITCH

4. WHAT ARE THE REQUIREMENTS OF THE VACUUM SYSTEM?

ANSWER: (A) OPERATES PROGRAMMER, (B) OPERATES SENSOR STRING, (C) OPERATES TEMPERATURE DOORS, (D) OPERATES VACUUM CHECKS (E) OPERATES VACUUM MOTOR, (F) OPERATES HEATER WATER VALVE

5. WHAT ARE THE MAJOR REQUIREMENTS OF THE SENSOR?

ANSWER: (A) SENSES PASSENGER COMPARTMENT TEMPERATURE AND SENDS SIGNAL FOR CORRECTIONS TO MATCH CONTROL SETTING, (B) SENSES OUTSIDE AIR TEMPERATURE AND SENDS SIGNAL TO MATCH CONTROL SETTING

6. WHAT IS THE MAJOR ADVANTAGE IN USING THE A.T.C. TESTER?

ANSWER: WILL MINIMIZE TIME TO LOCATE AND ISOLATE MALFUNCTION PROBLEM

7. HOW DOES THE A.T.C. TESTER FUNCTION?

ANSWER: BY INSERTING INTO CONTROL SYSTEM ELECTRICAL AND VACUUM CIRCUITS

8. WHAT ARE THE FOUR BASIC SECTIONS OF THE A.T.C. TESTER?

ANSWER: (A) MANUAL DRIVE CONTROL, (B) VOLTMETER, (C) TEMPERATURE DIAL CALIBRATOR, (D) VACUUM GAGE

9. WHAT TEST SHOULD BE FIRST IN A SERIES TO LOCATE A MALFUNCTION?

ANSWER: ALWAYS START WITH THE SIMPLEST, THE VISUAL CHECK.

10. WHAT TWO STEPS ARE MOST IMPORTANT IN DIAGNOSIS OF AN AIR CONDITIONING PROBLEM, TO SAVE TIME AND EFFORT?

ANSWER: (A) ACCURATE, DETAILED DESCRIPTION OF COMPLAINT, (B) BRIEF CHECK OF SYSTEM OPERATION BY OPERATING CONTROLS

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

THE CLIMATE CONTROL AIR CONDITIONING SYSTEM AUTOMATICALLY CONTROLS THE HEATING OR COOLING OF THE PASSENGER COMPARTMENT.

THE UNIT WILL HEAT OR COOL ACCORDING TO: (1) SELECTOR TEMPERATURE CONTROL SETTING, (2) INTERIOR TEMPERATURE OF PASSENGER COMPARTMENT, (3) AMBIENT TEMPERATURE.

TEMPERATURE DIAL SETTING AUTOMATICALLY CONTROLS BLOWER SPEED TO MAINTAIN THE TEMPERATURE SETTING.

CONTROL SETTING DETERMINES AIR DELIVERY ROUTING.

FOUR MAJOR REQUIREMENTS FOR OPERATION: (1) MECHANICAL, (2) ELECTRICAL, (3) VACUUM, (4) SENSOR.

THE FOUR DIVISIONS OF CLIMATE CONTROL AIR CONDITIONING DIAGNOSIS ARE: (1) THE MECHANICAL SYSTEM, (2) THE ELECTRICAL SYSTEM, (3) THE VACUUM SYSTEM, (4) SENSOR

THE TERM MECHANICAL REFERS TO THAT PART OF THE SYSTEM OPERATED BY MEANS OTHER THAN ELECTRICAL OR VACUUM.

THE ELECTRICAL CIRCUIT INCLUDES: (1) BLOWER CONTROL CIRCUIT, (2) COMPRESSOR CIRCUIT.

THE TERM "VACUUM" REFERS TO THAT PART OF THE REFRIGERATION SYSTEM CONTROLLED OR OPERATED BY VACUUM. SOME CONTROLS ARE BOTH VACUUM AND ELECTRICALLY OPERATED.

THE TERM "SENSOR" REFERS TO THAT PART OF THE REFRIGERATION SYSTEM-ELECTRICALLY AND VACUUM CONTROLLED THAT SENSES THE INSIDE AND OUTSIDE TEMPERATURE AND REACTS ACCORDING TO TEMPERATURE SELECTION.

COMFORT LEVEL WILL BE AFFECTED WHEN THERE IS A MALFUNCTION IN ONE OF THE COMPONENTS OR THE OVERALL SYSTEM.

OPERATIONAL CHECKS ARE MADE ON THE VEHICLE AND WHEN ANY COMPONENT IS NOT FUNCTIONING PROPERLY IT SHOULD BE REPAIRED OR REPLACED.

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENTS' COMPREHENSION OF MATERIALS PRESENTED.)

MULTIPLE CHOICE

1. THE PURPOSE OF THE CLIMATE CONTROL SYSTEM IS TO: C

   A. WARM THE PASSENGER COMPARTMENT
   B. COOL THE PASSENGER COMPARTMENT
   C. AUTOMATICALLY CONTROL THE HEATING AND AIR CONDITIONING COMPONENTS
   D. DELIVER MORE COOLING

2. THE A.T.C. TESTER IS DESIGNED TO TEST CONTROL PROBLEMS: B

   A. OFF-CAR
   B. ON-CAR
   C. BOTH ON AND OFF CAR
   D. NEITHER OF THESE

3. A HIGHER THAN NORMAL CORE TEMPERATURE INDICATES: C

   A. SYSTEM IS FUNCTIONING SATISFACTORILY
   B. LOSS OF COOLING
   C. LOSS OF EFFECTIVE COOLING
   D. BLOCKED AIR FLOW

4. BLOWER CONTROL CAN BE DIVIDED INTO WHAT TWO CATEGORIES? C

   A. BLOWER SPEED AND BLOWER CIRCUIT
   B. BLOWER CIRCUIT AND BLOWER MOTOR
   C. BLOWER TURN ON AND BLOWER SPEED
   D. BLOWER CONTROL AND BLOWER CIRCUIT

5. THE VACUUM MOTOR IS CONTROLLED: C

   A. BY VACUUM ONLY
   B. ELECTRICALLY ONLY
   C. BOTH ELECTRICALLY AND VACUUM
   D. BY MANUAL OPERATION

SUGGESTED READING FOR STUDENTS:

AUTO SERVICE AND REPAIR, STOCKEL CH. 32
AUTOMOTIVE ENCYCLOPEDIA, GOODHEART-WILLCOX PP. 635-646

THE NEXT LESSON IS: X-A-1(I) "OFFICIAL VEHICLE INSPECTION STATION LICENSE"